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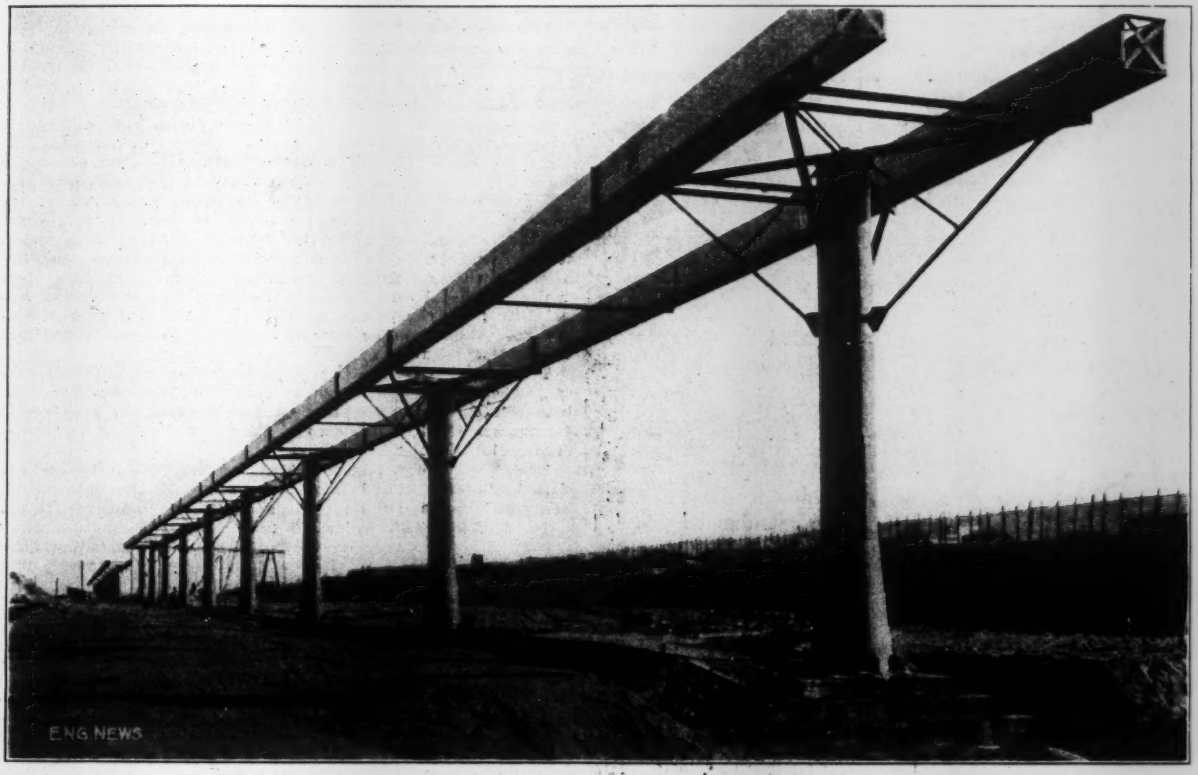
A Noteworthy Steel Trestle: Stock-Pile Trestle at Negaunee Mine

Trestles for dumping ore into stock piles at the iron mines are usually wooden trestles of the simplest construction; these trestles are taken down when material is shipped from the pile, to give room for working the steam shovel, which loads the ore into railway cars, and re-erected when the ore is again to be stocked. The Negaunee mine, Negaunee, Mich., five years ago started a new shaft (No. 3), which promised sufficient permanence to justify a better type of stock trestle, one which would save the cost of frequently demolishing and re-erecting and of complete renewal every five or six years, as necessitated by timber trestles. On the suggestions of Stuart R. Elliott*, superintendent of the mine, a center-column steel trestle (allowing steam shovels to work along the ground without interference) was designed by the Wisconsin Bridge & Iron Co., and this trestle has been in service now for two years with satisfactory results. It presents several radical novelties in steel construction.

The trestle is a double-track plate-girder structure of 20-ft. track spacing with a single central line of columns. It is 42 ft. high from ground to rail. The plate-girder portion of the structure, the columns, and the method of supporting the girders on the columns are quite unusual. The single-column construction allows of running the steam shovels along the ground so close to the columns that they can clean up the whole ore pile except a small amount of material just at the foot of each column. Thus the trestle is permanent and its length of life should be equal to that of bridges and other steel structures.



PERMANENT STOCK-PILE TRESTLE AT NEGAUNEE MINE SHAFT NO. 3

(Columns, 4-ft. reinforced-concrete cylinders in ¼-in. steel shells. Girders, cantilever system of 114-ft. spans with 76-ft. suspended spans, 42-in. plate-girders, for 30-in. track gage. Trestle 2594 ft. long, 42 ft. high rail to rail, tracks 20 ft. c. to c. Designed for 10-ton load.)

The columns are 4-ft. cylindrical reinforced-concrete columns with the base enlarged on a taper to a bottom diameter of 6 ft.; they are inclosed in ¼-in. steel shells, which serve as forms for the concreting as protection to the shaft against damage by the ore and the steam shovel.

*Mr. Elliott recently read a paper describing the trestle, before the Lake Superior Mining Institute. The present article is based on data given in that paper.

Each column rests on an independent base, which is a stepped concrete footing 6 ft. deep, 12x26 ft., the long dimension transverse to the track. Footing and column are reinforced by fifty-two 7/8-in. steel rods, which rise from the base into the shell and are tied at the bottom to seven old rails, running in the long direction of the footing. The rods, lap-spliced 20 ft. above ground, and spaced by several rings, continue to the top, 38½ ft. above ground. The shells are strongly anchor-bolted to the footing. At the top the concrete of the column is rounded and smoothed off with a rich mixture to prevent entrance of water between concrete and shell.

The columns are 114 ft. apart, center to center. This great length of span for the light load (10 tons moving load) and the correspondingly shallow girders is made feasible by the use of cantilever span construction. A 38-ft. girder section at the column is connected with bracket support to the column and forms the fixed span, while the 76-ft. intermediate portion forms the suspended span. Each girder is a latticed box section, 30 in. wide, of which each half is a built channel 42 in. deep, with ¼-in. web-plate, flanges turned in.

The construction for supporting the girders on the column is a framework in the shape of an inverted square pyramid, comprising four bracket struts extending out at angle of 45° from the columns and transverse and diagonal top ties of 8-in. channel. There is also a cross-tie in the middle of each suspended span.

The girders carry 5-in. sawed ties 4 ft. long, on which is laid the 40-lb. rail. Bolted to the under side of the ties, and immediately outside of the two girder web-plates, are two 4x4-in. longitudinal timbers, which prevent transverse shifting of the track.

The cost of the entire trestle (2594 ft. long) was $51,228.92, or $19.71 per lin.ft. erected, including decking, ties, walks, rails, etc. Of this total, the steel-girder superstructure and the column shells (and trestle bents in the middle portion, which is of more normal construction) amounted to $35,100, or $13.53 per ft.

Comparing the trestle with a wooden trestle in point of cost, including maintenance and accumulated interest, the following facts are discovered: The greater first cost of the steel trestle is just made up (by the saving in maintenance, i.e., annual demolition and reërection and repairs) in 6½ years, the average life of the wooden trestle. For any longer period than 6½ years, the steel trestle shows a marked financial advantage, because of the renewal cost of the wooden structure, so that at the end of 20 years a saving of $117,000 is realized. Should the mine continue producing beyond the 20 years, and the steel trestle still be in good shape, the saving would continue to grow.

Quarry Accidents in the United States during 1913, according to A. H. Fay, of the U. S. Bureau of Mines, caused the death of 183 men. The number of men employed in the industry was 106,278, and the death rate per 1000 employed was 1.72, as compared with 1.88 during 1912. The principal hazards of quarrying appear to be equally divided between explosives, falls of quarry material, and haulage. Accidents from these causes represent nearly two-thirds of the fatalities. In France the fatality rate for quarry accidents is seldom more than one in every 1000 employed, and in the year 1912 was even less than one; in Great Britain, for the ten years 1895 to 1904, the annual rate was 1.09. The high American rate is attributed to less stringent regulation and less systematic inspection.

An Instance of Lightning on a Steel Dome and Reinforced-Concrete Walls

Numerous requests have been received for specific information as to the performance of reinforced-concrete structures subjected to the play of lightning but below are the first complete and accurate observations that have been put on record. They are reported in a letter of C. D. Perrine, of the Argentine National Observatory, at Cordoba, published in *Science*, Oct. 9, 1914. It is evident that the domes and reinforcing were carefully grounded to lead lightning discharges safely to ground. Freedom from disturbances within the domes was expected as the construction was most favorable for such protection.

The center of the storm, judging from the clouds and their motions, was not over a mile south by southeast of the observatory. In nearly all the storms which I had seen here previously the discharges were nearly all between clouds. (Perhaps because most of them occur at night?) In this storm nearly all of the discharges were between the clouds and earth.

The direction of motion of this storm, as is usually the case, was from south to north. After some half dozen discharges close to the south there was a heavy one to the northwest about three hundred meters away—then another to the northeast about the same distance.

On account of this being a heavy storm and apparently passing directly over us, I was interested to see what the effect would be on our two new reinforced-concrete walls and steel domes sheathed with galvanized iron, and was outside among the central group of buildings and not over 100 ft. from the domes in question, one of them in full sight.

A minute or two after the flash to the northeast, mentioned above, there was a general illumination close by, followed almost instantly by the ripping sound of a very close stroke. The interval between the flash and the sound was certainly not over $\frac{1}{10}$ second. To me the sound appeared to be made up of three or four separate discharges blended into one—not consecutive.

The power and light currents were cut off until about 6 p.m., when it was found that fuses had been blown on our lines (which were special ones) just outside the step-down-station, some 400 meters away. No other effects of the storm were noticed in or near this station.

The dome which had just been completed was barely out of sight from where I stood and no one at the observatory seems to have seen the actual flash. A peon, however, in the grounds of the Meteorological office about 100 meters away had a full view of both domes and buildings, was facing them and saw the flash just over and about the new dome. This accords well with the direction and distance from my point of observation.

After hearing of this observation I made a careful examination of the dome and in particular the connection of the copper cable with the track upon which the dome revolves, which forms the connection between the metal dome and one of the vertical I-beams embedded in the concrete for grounding the circuit. The lightning-rod proper extends about a meter above the highest part of the dome and terminates in a brush of heavy wire. No signs whatever of any discharge have been found at any point about the dome.

Close to the dome stands the wooden derrick which was used in its construction, the top of which is about 2 ft. higher above the ground than the lightning-rod. Three wire-cable guys lead off to trees; two of them actually touch the ground—but scarcely so—and a fourth goes to a brick building. The cable used for lifting did not touch the ground. Careful examination of all of these points failed also to disclose the slightest sign of a spark.

The three wires of the alternating power circuit pass close to both dome and derrick.

The bolt which struck the dome was undoubtedly not a light one for it frightened badly a number of persons in the residences near-by and was described by several as a very bright flash. I do not think, however, that it was an especially heavy one, possibly not so heavy as most of the others which struck in the vicinity.

The peon who saw it from the neighboring quinta, was seated at the time under a shed and watching the dome. He says the flash appeared to descend as a single ray, striking

the lightning rod and then the whole surface of the metallic dome appeared to be covered with sparks or flashes.

It seems certain, therefore, that the dome was actually the principal point of discharge for a fairly heavy flash of lightning. (It is uncertain how much of the discharge was taken by the derrick, but it would appear to have been relatively small.) Also the induced currents in the light and power lines were sufficiently heavy to blow the fuses in both.

At the time the bolt struck, there was a peon inside the closed dome, cleaning the running-gear. When questioned he said he had felt nothing nor had he noticed anything unusual beyond the heavy noise.

This experience seems to be a fairly severe test for such a construction—a metallic dome surmounting concrete walls which are heavily reinforced with iron—the metal in the walls having a good ground connection and being connected also with the dome.

Failure of the Reinforced-Concrete Customs House at La Ceiba, Honduras, C. A.

In ENGINEERING NEWS, Sept. 17, 1914, p. 607, there was printed a brief note recounting the failure of a roof slab in the reinforced-concrete Customs House under construction at La Ceiba, Honduras, in which five men were killed, including the designer of the building, who was an American. Since then we have received from F. J. Parmele, Assistant Engineer, Vaccaro Bros., of La Ceiba, an account of the failure.

The building was being erected for the Honduras government by a contracting firm, which was also the designer of the structure, plans for which were accepted without verification by the government, and the construction for which was carried on without governmental inspection. The building was an extremely simple structure, 124x108 ft. in plan, with one story over the whole area 20 ft. high, and a second story over part of the area 12 ft. high. The main structural elements in the design were square columns 12x12 in. in section, reinforced with corner rods, and spaced on the corner of the bays 20x21 ft. 3½ in. The long dimension of the bay was spanned by 9x12-in. beams reinforced with five ½-in. and two ⅜-in. rods bent up over the columns and lightly stirruped. The roof of the first floor, which also formed the floor for the second floor in the two-story portion, was a 6-in. floor slab spanning the 20-ft. bay between beams, reinforced with ½-in. bars 12 in. c. to c., 2 in. from the bottom of the slab. The second-story portion was disposed as to columns or partitions without apparent regard to the supporting columns beneath, a decidedly poor feature of design, but one which apparently did not cause failure, as the collapse occurred in the one-story portion of the building.

The failure took place immediately after the removal of the forms under the roof of the one-story portion, and covered an area of about 50x60 ft. It was found after the failure occurred that the plans had not been followed in several respects, notably in the thickness of the roof slabs and in the design of the columns. As is shown by one of the columns, in the accompanying view, which is taken from the second story looking down into the hole made by the collapse, the columns were built in a very curious fashion. Instead of the straight 12x12-in. section through their entire height of 20 ft., they were made 24x24 in. in section for a height of 15 ft., and then were offset to a 12-in. square for the remaining height of 5 ft. to the beams. The reinforcement throughout was of the designed 4½-in. twisted steel bars, wired together by 12-in. spacers.

The roof, which was intended to act as a floor at a future date, as stated above, was supposed to be 6 in. deep. The contractor had no roofing material to bring the surface of the roof up to the proper draining grade, so he added 7 in. of concrete at the high end of the roof; then covered the whole with a light metal lath, and added a top dressing 1 in. thick, making a total depth of 14 in. at one end of the roof, reducing to 6 in. at the corner. The reinforcing, however, was the same as though it had been a 6-in. roof. The initial failure occurred under the thickest section of the roof slab.

In addition to the poor design, the method of construction was not up to standard. The mix was very lean, being about 1 part of cement to 8 parts sea sand, which carried about 10% gravel. In portions of the débris, Mr. Parmele states that he discovered charcoal, broken glass, machetes and nails, all of which was part of débris left from the burning of a building which had previously occupied the site. The method of placing the forms was neither good nor economical. They were, for the most part, made of lap siding, very poorly put together, so the great portion of cement and water escaped. The centering had buckled in several places, causing sags and cracks.

LOOKING DOWN INTO HOLE LEFT BY COLLAPSE OF ROOF OF CUSTOMS HOUSE AT LA CEIBA, HONDURAS
(Note column in right foreground.)

The government has placed an embargo on seven other contracts held by the same contractor. Investigation has shown that other buildings under construction by the contractor were equally bad in design and construction.

The New York Rapid Transit Railway Extensions*

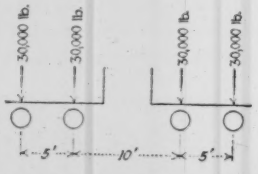
By F. Lavis†

IV--Design of Structure and Track

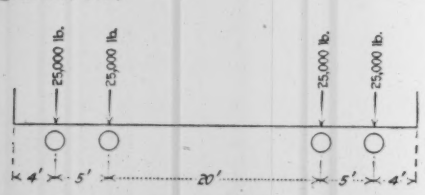
LOADINGS—The subway and elevated structures are all designed in accordance with the specifications for assumed loadings, and strengths of materials and methods of calculation, as given in detail in a paper presented to the American Society of Civil Engineers by Henry B. Seaman, formerly Chief Engineer of the Public Service Commission, and under whose direction they were worked up (*Trans.* Am. Soc. C. E., Vol. LXXV, p. 313). The principal provisions governing the design for steel structures are given below:

The railroad trains on bridges shall be estimated as required by specifications of railroad company.

Elevated or subway trains shall be estimated as a continuous load of 2000 lb. (2k) per lineal foot of each track, or a single local concentration of two adjacent motor trucks with axle loads spaced as follows:



Trolley cars shall be estimated as continuous at 1500 lb. (1½k) per lineal foot of each track, or as a local concentration of one ash car with axle loads spaced as follows: (Note, the ash cars are special cars used by the B. R. T. for removing ashes, etc.)



The roadbed for trolley cars on bridges shall be assumed as 12 ft. wide, and shall be capable of carrying the loads specified for roadway of bridges.

The roadway load for bridges shall consist of a uniform load of 120 lb. per sq.ft. of surface, or a local concentration of 40k on one axle with a wheel gage of 8 ft. This load may be assumed to cover a space of 12 ft. wide by 40 ft. long.

The roadway load over subways shall consist of a uniform load of 600 lb. per sq.ft. of surface, or a single local concentration of 200k on four wheels, 12 ft. between axles and 8 ft. gage. These concentrated loads shall be assumed to be distributed over an area of 2x2 ft. on the pavement and thence through the earth at a slope of one-half to one. Sidewalks over subways shall be assumed as loaded at 600 lb. per sq.ft.

Footwalks for bridges and platforms of elevated R.R. station shall be estimated as loaded at 100 lb. per sq.ft. of surface. Subway platforms shall be estimated as loaded at 150 lb. per sq.ft. of surface.

IMPACT—Loads due to trains or trolley cars shall be increased for impact in accordance with the following formula:

$$S = 125 - \tfrac{1}{8}\sqrt{2000\,L - L^2}, \quad (S = 0 \text{ when } L = 1000 \text{ ft.})$$

where S = Increase in per cent.; L = Length, in feet of applied loading which produces maximum stress in the member. Not to exceed 1000 ft.

No increase shall be made for impact to horizontal loading (centrifugal or traction forces.)

Wind—Provision shall be made for wind pressure acting in either direction, horizontally, of 30 lb. per sq.ft.

Traction—Provision shall be made for the sudden starting or stopping of a train 500 ft. in length, estimating the coefficient of sliding friction at 10%.

Temperature—Provision shall be made on bridges, for a variation in temperature at 120° F. (a difference of 40° in the temperature of the chords of the same truss, or in that of adjacent trusses of the same structure shall be considered in spans of more than 300 ft.

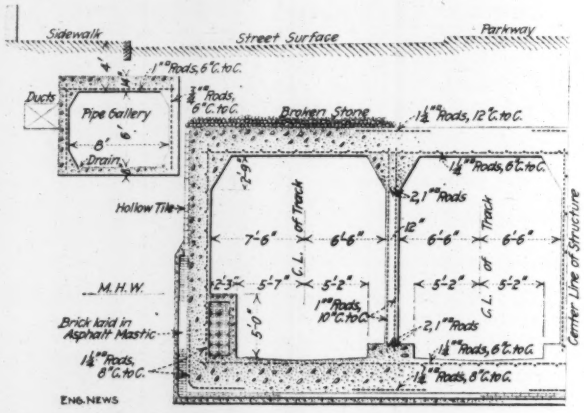


FIG. 10. HALF SECTION OF B. R. T. SUBWAY ON FOURTH AVE., BROOKLYN, BUILT IN REINFORCED CONCRETE WITH PIPE GALLERY UNDER SIDEWALK

The following table shows the unit stresses (1 k = 1000 lb.) allowed for steel used in the structure taken in conjunction with the foregoing loadings.

Nature of stress	Steel: Medium structural	Cast
Tension (Net)	20k	16k
Compression. (1 Diam.) (Gross)	20k	20k
Compression (12 Diam.) (Gross)	16.5k	
Compression, Columns	$\frac{20k^*}{1+\frac{l^2}{8000r^2}}$	
Bending (Beams, outer fiber)	20k	
Bending (Pins, Rivets and Bolts)	30k	
Shear (Pins, Rivets, web) (Net sec.)	15k	16k
Bearing (Pins, Rivets and Bolts)	30k	
Bearing (Roller) per lineal in.	0.75kd	

l = Length of column, in inches.
r = Least radius of gyration of cross-section, in inches.
d = Diameter of roller, in inches.

*Note: Compression members in steel and iron shall not receive greater unit stress than that allowed for 12 diameters.

When beams and girders are embedded in concrete, the concrete will be assumed to take 20% of the loading.

In case of field rivets 25% excess will be added to the number of rivets required as above. (When machine-driven this may be reduced to 20% excess.)

PRELIMINARY INVESTIGATION

Extensive borings, both wash and core, were taken before construction to determine as nearly as possible the character of the subsoil, depth to rock, etc., although the latter is extremely irregular. All existing structures, both above and below ground, were located as well as possible so that proper provision might be made for taking care of them, though the actual final disposition of many of the small pipes, etc., was not determined, until they

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†Consulting Engineer, 50 Church St., New York City.

were all uncovered by the excavation and accurately located.

General Design

Speaking generally, the present designs are based on the use of structural-steel frames with concrete jack arches between. The use of reinforced concrete is very limited. It seems to be generally considered that the use of the structural-steel frame greatly facilitates the support of the street decking during construction, because just as soon as a bent is set up and riveted, the load may be transferred to it.

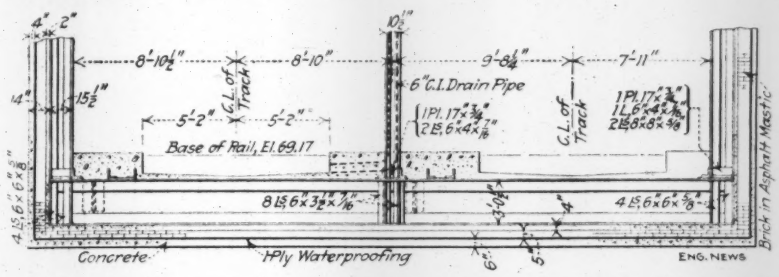


Fig. 11. B. R. T. Subway on Broadway at Canal St., Showing Very Heavy Floor to Resist Upward Pressure of Water

Under the requirement, that the street surfaces shall be maintained and their use for vehicular and other traffic be uninterrupted, it is generally necessary, on account of the width of the excavation, to carry this decking on timber supports, which, as will be seen later, fill up a large part of the excavated space. The construction of reinforced-concrete structures under these conditions is, therefore, somewhat difficult and liable to be patchy, but by proper care in arranging the timbering, the steel-framed bents can be erected easily.

The usual members employed in the steel-frame type of construction in these subways are small enough to be easily handled, so that reinforced concrete has little advantage in the use of small construction units. The ease of construction of the steel-frame structure, and advantages of support more than outweigh any disadvantage in the necessity of using skilled steel erectors, as against the supposed ability to use unskilled labor for reinforced concrete, even though the form work for the concrete with the steel structure is little less than it would be for ordinary reinforced concrete. Fig. 10 shows the reinforced-concrete design adopted in 1908 for the 4th Ave., Brooklyn, lines, which, however, were built mostly in open cut.

The use of the specially rolled "bulb" angles, used on the original subway, has been abandoned and only standard steel shapes are used. Usually the columns rest directly on the concrete, as shown in in the normal sections, Fig. 8, but in certain places I-beam grillages are provided. No stone-block footings are used. Where the ground is soft or where water pressure exists, specially designed floors are necessary. One of the most important of these places is at Canal St., where the subgrade of the lower level is 40 ft. below M. H. W. or normal ground-water level. The heavy girders and thick concrete floor required at this point is shown in Fig. 11. A typical floor to meet conditions below ground-water level is shown in Fig. 15, which is a cross-section of part of the Lexington Ave. subway, where the line passes over what seems to have been an old swamp. This special type was designed principally for the purpose of carrying the structure on the soft ground. Just north of this, at Lexington Ave. and 128th St., where the subgrade is considerably below the water level, a typical design (Fig. 16) of reinforced concrete, for resistance to water pressure in rock, is used.

On account of the fact that the New York rock, a micaceous gneiss, is well known to present difficulties of support, that is, on account of bad seams, etc., to be "heavy" in places, it was decided to use a reinforced-concrete lining for the deep-level tunnels under Lexington Ave. It was found on opening up the work, however, that the necessary temporary supports of timber made this type of construction difficult to execute satisfactorily, and a change was, therefore, made to the design shown in Fig. 13. This, as will be seen, permits the construction of the center wall and the haunches with the steel columns and longitudinal I-beams, so that a direct center support can be built to the roof, which is generally sufficient for

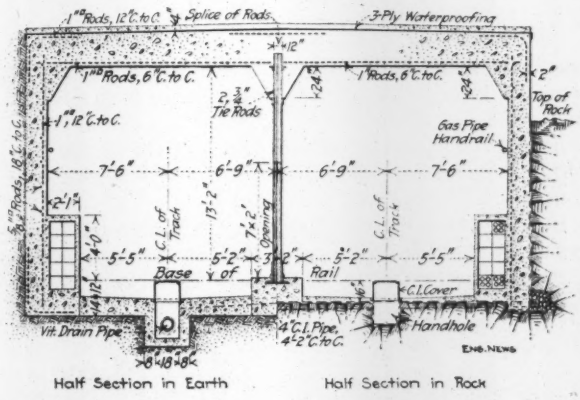


Fig. 12. Reinforced-Concrete Subway on Lexington Ave.

(This shows the upper level. The tracks on the lower level are in tunnel with a roof of two arches supported on a center wall and the sidewalls.)

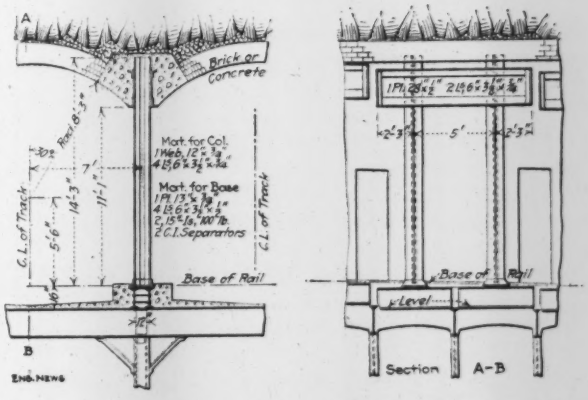


Fig. 13. Alternative Design for Center Wall Using Structural Steel Instead of Reinforced Concrete

the support of the overlying rock without timbering during the construction of the concrete arches.

The unstable character of the rock and the variation in thickness of the cover involved some changes in the location of the tunnel portals, making it necessary to shift them back in almost every case to get sufficient depth of overlying rock cover. This contingency is, of course, covered by the provision in the contract for slight variations in total quantities. The heavy ground on some of the sections on Lexington Ave. necessitated the design of considerably heavier steel sections, as shown in Fig. 17 for use at these places.

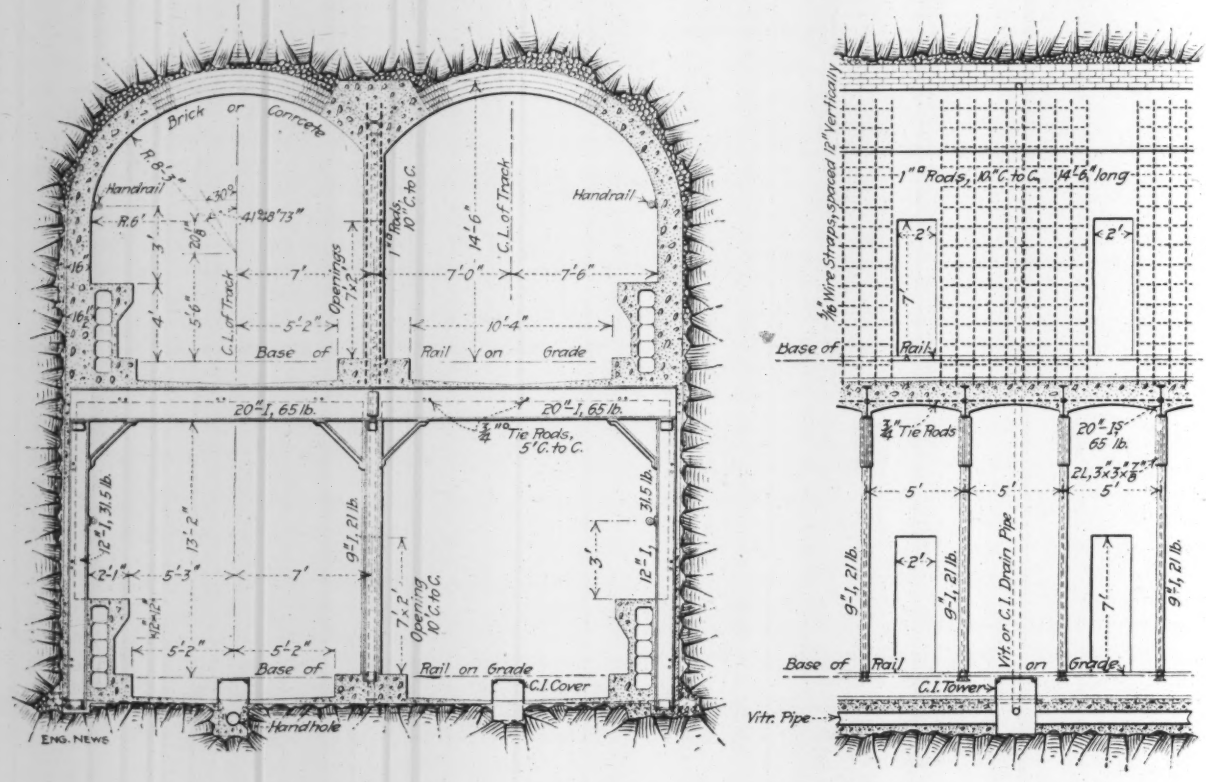


FIG. 14. DOUBLE-DECK SUBWAY ON LEXINGTON AVENUE BUILT WHOLLY IN TUNNEL

Further notes in regard to the construction of special sections, such as the Harlem River Tubes, steel and reinforced-concrete elevated sections, etc., will be found under their respective headings.

CROSS-SECTIONS—During the early days of the Public Service Commission (1907-08), there was considerable discussion in regard to the desirable dimensions of the cross-section of the new lines proposed at that time as extensions and further developments of the rapid transit lines then in operation. It was not thought advisable to conclude further operating contracts on the basis of those made for the original subway, and it was found difficult to arrive at any other which was agreeable to both parties. It was then decided to go ahead with the construction of the 4th Avenue Brooklyn line and Centre St. loop, leaving the question of operation to be decided later. It was thought that if neither the Interborough nor B. R. T. would meet the views of the Commission in regard to terms of operation, a third party might be found, and as there then seemed to be a possibility that this might be one of the existing steam railroad lines, it was decided to provide clearance for standard railroad equipment and the designs of these two sections were modified accordingly to provide this. As all doubt in regard to the future operation has now, however, been eliminated, it has not been thought necessary in the design of the new lines now to be built to provide for larger equipment than it is known will be used, and the clearances decided on for the new lines are only slightly larger than those provided in the present subway, as is shown in the following table, and in more detail in the typical cross-sections which are shown.

In Fig. 8 (of the previous article) is shown a cross-section of the 7th Ave. line of the Interborough, which is the minimum section for the new lines. Figs 12 and

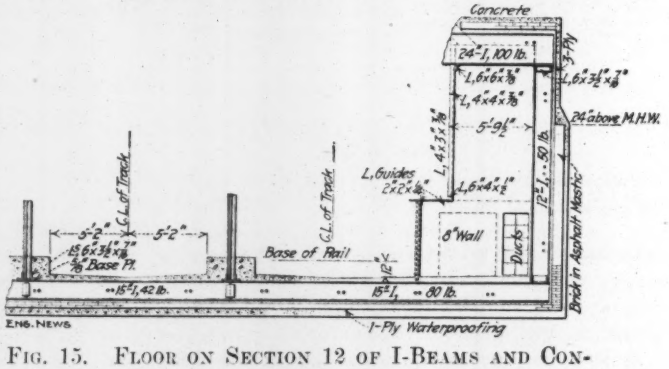


FIG. 15. FLOOR ON SECTION 12 OF I-BEAMS AND CONCRETE

14 show the Lexington Ave. line, which is to be operated by the Interborough, but which was designed before the question of operation was definitely decided. Fig. 11 shows the cross-section of the Broadway 59th St. route of the B. R. T. The following table shows a general comparison of the dimensions of the original subway and those since adopted.

	Height above top of rail	Width*
Original subway	12 ft. 4 in.	12 ft. 6 in.
Fourth Ave. Brooklyn and Centre St. loop	14 ft. 6 in.	14 ft. 0 in.
New subways:		
B. R. T.	12 ft. 8 in.	14 ft. 3 in. & 13 ft. 6 in.
Interborough	12 ft. 3 in.	13 ft. 6 in. & 13 ft. 0 in.

*From center of columns between tracks to face of side wall. (Columns about 8 in.)

Note—These are dimensions on tangents and are increased on curves to provide equivalent clearance.

Cross-sectional dimensions of other rapid transit subways in the United States are approximately as follows, there being many minor variations:

	Height above top of rail	Clear width
Boston, Tremont St., 1898	13 ft. 10 in.	12 ft.
Boston, Washington St., 1905	14 ft. 5 in.	12 ft. 2 in.
Cambridge, 1910	14 ft. 9 in.	12 ft. 6 in. (a)
Philadelphia, 1907	14 ft.	12 ft.
H. & M., 6th Ave., 1908	12 ft. 10 in.	13 ft. (b)

Note (a)—The Cambridge subway is large enough to take standard steam railway equipment, the tracks are 12 ft. on centers.

Note (b)—Sidewalk over duct bench at side.

The question of cross-section is one of considerable importance. It is determined largely by the size of the cars, the economic limit of which is controlled largely

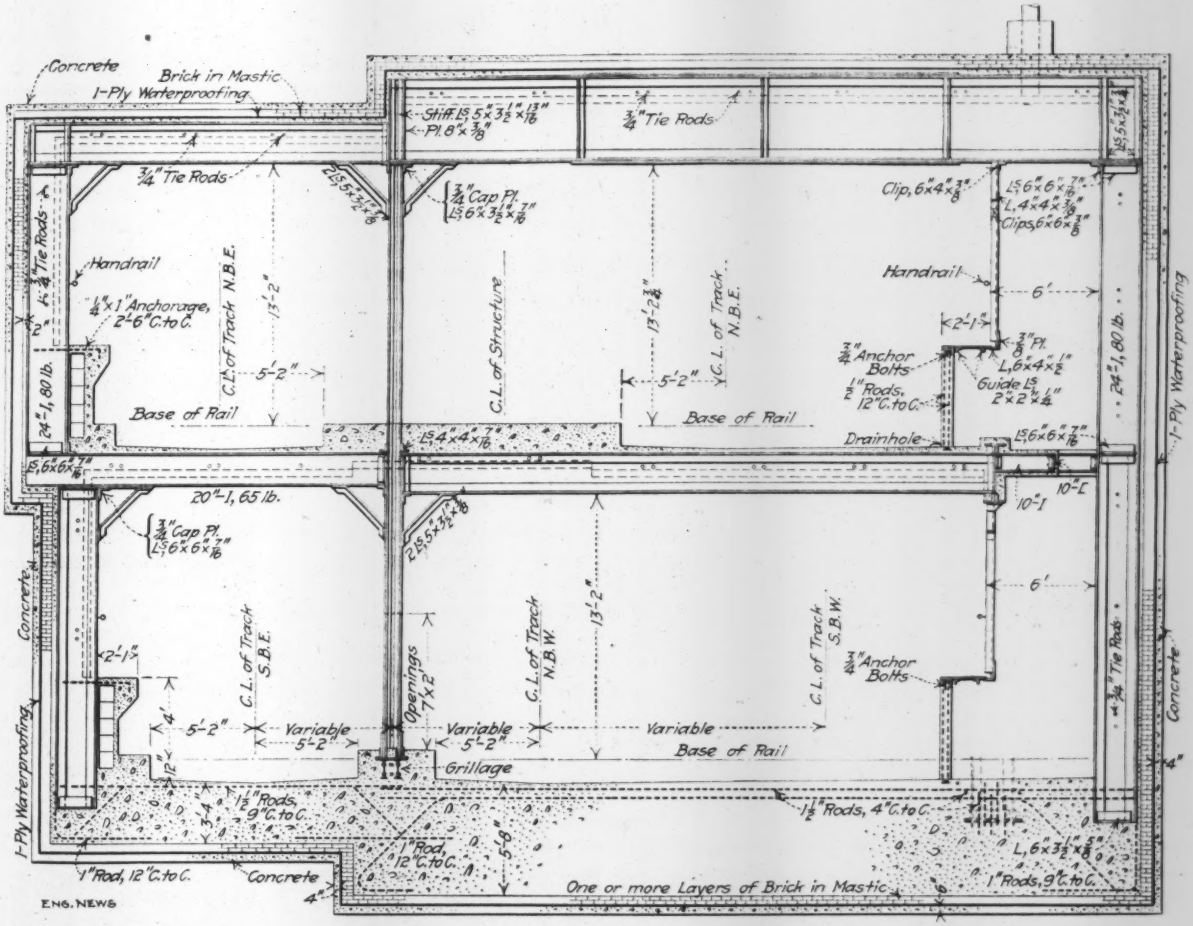
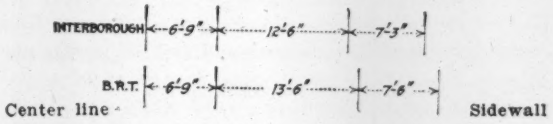


FIG. 16. LEXINGTON AVE. SUBWAY AT 129TH ST. DOUBLE-DECK STEEL-FRAME CONSTRUCTION WITH HEAVY REINFORCED-CONCRETE FLOOR

As is shown on the various cross-sections, provision is made for building the conduits for the electric wires, in a side-bench wall with a walk on the top, instead of placing them in the sidewalls, as in the old subway.

The standard track spacing for four-track subways finally adopted is as follows; from the center line of the four tracks to face of sidewalls:



by the time necessary to load and unload them at express stations during the rush hours. Under present operating conditions, the spacing of trains is determined probably as much by the length of station stops as by ability to run the trains more closely together between stations. It is probably difficult to determine the exact economic dimensions of a car which will hold the maximum number of people and at the same time permit the minimum time of stopping. As has already been pointed out, the B. R. T. has decided to use a larger car, but the Interborough will probably of necessity be obliged to

continue the use of equipment interchangeable with that now in use, and therefore, all new lines which are to be used exclusively by this latter company, are designed on that basis, only very slightly larger than that now in use.

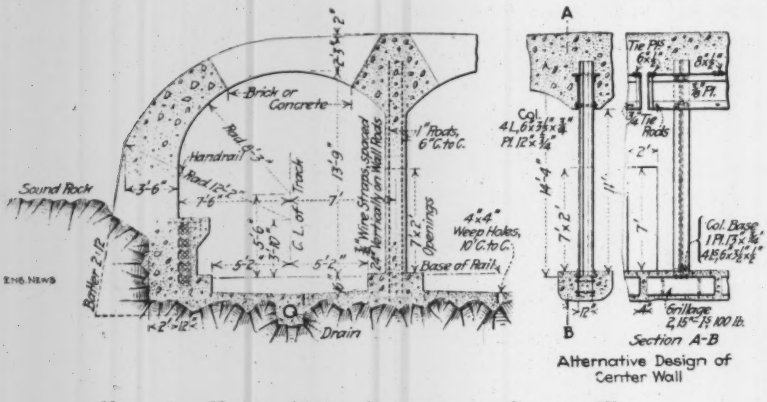


FIG. 17. HEAVY STEEL SECTIONS IN CENTER WALL, LEXINGTON AVE. LINE AT 59TH ST.

The cross-section has also, of course, an important bearing on the question of ventilation; this, however, is discussed more fully under that heading.

On some of the routes when the designs were made and construction started, it was uncertain whether they were to be operated by the B. R. T. or the Interborough; provision was, therefore, made as is shown in the sketch, Fig. 18, for an adjustable edge to the platforms, so that either the 9-ft. Interborough or 10-ft. B. R. T. cars could be used.

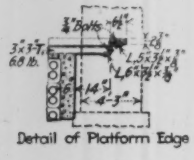


FIG. 18. DETAIL OF ADJUSTABLE PLATFORM EDGE

TRACK CONSTRUCTION—A standard track construction has been adopted for all the new lines, by conference and agreement between the two operating companies and the Public Service Commission. Rails are to be 100 lb. openhearth B section of the Am. Ry. Eng. Assoc. Ties, yellow pine 6x8x8 untreated, with flat-bottom shoulder tie-plates 7½x9x½ in., and 6-in. cut spikes. In the subways trap-rock ballast ½ to 1 in. will be used as a cushion over the concrete floor; as the head room is limited, there will be only about 6 in. of ballast under the ties. Ample drainage is provided by drains in the concrete floor. Judging by experience with the ties in use on the present rapid transit lines it has been thought that treament by creosote or other preservative will not be necessary.

Guard rails are to be used on all curves of less than 2000 ft. radius; those under 700 ft. radius will also have rail braces on the guard rails, as well as for the outside rails. Rolled manganese rails are to be used practically entirely for all frogs, switches, cross-overs, etc., and on all curves less than 700 ft. radius. In regard to the necessity for the use of manganese rails, which cost about 2½ times as much as openhearth, reference may be made to the experience of the Boston Rapid Transit lines (ENG. NEWS, Oct 22, 1908, p. 458), where on a certain curve bessemer rails lasted only 60 days, a cast manganese rail had shown only about ½ in. wear in six years. There is, of course, not only the wear of the rail to be considered, but the cost of changing due to the abnormally high cost of track work under the extremely heavy traffic and in the confined space in the subways.

At stations, in order to facilitate cleanliness and sanitation, a special type of track construction similar to that used in the Pennsylvania terminal station in New York* and the Detroit River tunnels† is to be used. A cross-section is shown in Fig. 19.

The track material is to be bought by the Public Service Commission under contracts and at unit prices to be bid for the various items required; it is to be stored and issued on requisition to the operating companies who will install the track as part of the "equipment."

TRACK LAYOUTS—The arrangement of tracks at junction points, so as to avoid crossings at grade, with the consequent delay, as well as danger, has been the subject of considerable thought and study. In the present subway there are three junction points, at Bowling Green, City Hall, and at 96th St. The first two being merely junctions of double-track lines, where only one class of trains, either local or express, has to be cared for on each route, did not present any particular difficulty, it being only necessary to depress one track under the other two. At 96th St., however, where two double-track lines come together into a four-track section, and where express and local trains have to be directed from any one line to any of the others (in the same direction), the problem is more complicated.

The present layout at 96th St. is shown diagrammatically at *D*, Fig. 20; it will be noted that the switches and slip crossings are all on the north side of the station, and that as trains from either branch may and do continue

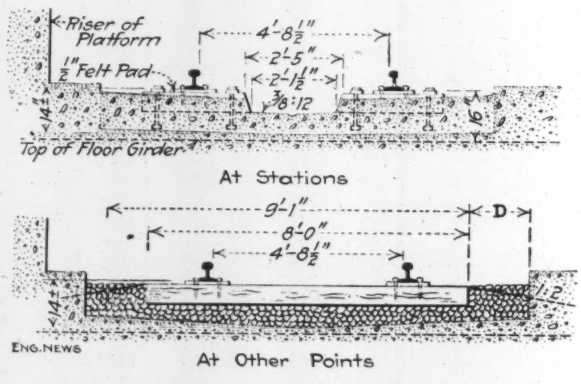


FIG. 19. TYPICAL CROSS-SECTIONS OF TRACK

as either local or express, there is frequently some delay to trains before they can approach the crossings to enter the station on the proper track. This would not be noticeable on lines of ordinary traffic, but under the conditions existing during the morning and evening rush hours in New York, the slightest delay may be magnified into a serious congestion of the whole system.

The number of such junction points on the new lines has been considerably increased and typical methods of

*"Trans.," Am. Soc. C. E., Vol. LXIX, p. 305.
†"Trans.," Am. Soc. C. E., Vol. LXXIV, p. 349.

overcoming the difficulties are shown in the three diagrams *A*, *B* and *C* of Fig. 20.

So far as possible in all the designs for the new lines the engineers have tried to avoid any slow points, such as switches, crossings, etc., at places other than close to stations where trains must stop, and to locate them on the *farther side* rather than on the near side where they would be reached before the train enters the station, and where in case the line is not clear the train would have to make a signal stop before reaching the switch as well as the station stop after.

The diagram at A shows the track layout at 125th St. on the Lexington Ave. line. It will be noted that coming from the north, trains from either branch reach the station without crossing any switches, are both on the

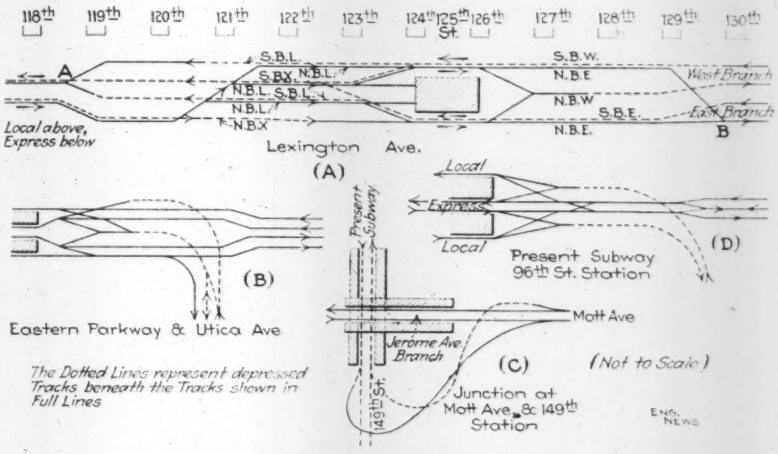


FIG. 20. VARIOUS TRACK INTERSECTIONS

same level and on their same respective sides of the station. Continuing south, those trains which become expresses from this point, pass the required switches within 300 or 400 ft., while the locals have a switch, which is, of course, a slow point, at 119th St. (about 1500 ft. beyond the station). This, however, is of little importance, so far as causing any delay in the south bound movement of the local trains is concerned, as their next station stop is at 116th St.

Coming from the south the expresses reach the upper level in the east side over practically a straight line with no switches, with just enough ascending grade to slow them down. Leaving, they take one or two switches as they are diverted to either the east or west branch, but both within 300 ft. of the station. The locals coming from the south have one or more switches to pass before they reach the station; this, however, is not of importance especially as they do not anywhere come in contact with the expresses. As may be seen these latter switches are not necessary for the operation of through trains, as trains from either side of the station going north reach either branch without a crossing of tracks of trains going in the opposite direction, but are put in for convenience, to provide two extra side tracks for any emergencies of operation at this junction.

The other two diagrams are self-explanatory, except to say that at Eastern Parkway and Utica Ave., diagram *B*, the arrangement is not quite so elaborate as there is not expected to be such heavy travel on this section as to warrant large expenditures to prevent short delays.

Effect of Creosoting on Strength of Oregon Fir Piling

The August, 1914, bulletin of the American Railway Engineering Association is entirely given up to a paper by H. B. Macfarland, Engineer of Tests, Atchison, Topeka & Santa Fé Ry., entitled "Tests of Oregon Fir Piling." The object of the tests was to determine the effect of the steaming process of creosoting as practiced on the Pacific coast upon the physical properties of the piling. Mr. Macfarland states that tests have been made demonstrating that the physical structure of Oregon fir piling is decreased considerably by the boiling process of creosoting, but claims have been made that the steam creosoting plant did not deteriorate the physical strength of the material except possibly on the outer surface. These statements have been based on a small number of small-size tests, so the railway decided to make a large number of tests on both full-size piles and on small pieces cut from piles. The piles to be tested were selected and treated under the observation of the office, and were tested for transverse strength, compression parallel to grain, compression perpendicular to grain, shearing parallel to grain, moisture and creosote absorption. The minor specimens, cut from the creosoted piling, were tested in transverse strength and compression.

The material in treating is subjected to three processes, namely, steaming, removing the moisture and filling with creosote.

When introduced into the tank the logs are thoroughly wet as they come from salt water. They are brought to a temperature of about 330° in a period of one and one-half hours by the introduction of steam. The temperature is maintained for one and one-half hours. A vacuum of about 28 in. is then produced and the temperature reduced to a minimum of 190°. The vacuum process is maintained for 10 hours. The tanks are then filled with oil at 190° temperature and an average pressure of 75 lb. is maintained for a period of five hours, until the piles have taken up the proper quantity of oil. The oil is then transferred from the treating tank to the general storage tank, after which the timbers are removed.

The general conclusions are as follows:

In every case the treated material shows a decided loss of strength as compared to untreated. The greatest loss is in transverse strength due to the influence of treated sap-wood. The loss of compression strength is considerable. The result of the tests indicates the following conclusions relative to the effect of steaming process of creosoted Oregon fir piling: (1) Depth of penetration of creosote was mainly dependent upon the depth of sap-wood; (2) heart-wood of Oregon fir piling was almost impervious to treatment; (3) depth of penetration of creosote was the same in the butts as in the top; (4) depth of penetration of creosote should be interpreted as to mean the depth of active penetration; (5) tests of minor specimens show that injury to fiber through method of treatment is not localized to treated fiber alone, but extends throughout the whole specimen; (6) transverse strength of Oregon fir piling was decreased 42%, due to steaming process of creosoting; (7) compressive strength perpendicular to the grain was decreased 32% through the steaming process; (8) compressive strength parallel to the grain was decreased 27%, due to steaming process; (9) in general average, the strength of Oregon fir piling subjected to steaming process of creosoting was only two-thirds its original strength.

Snow Disposal Experiments in Manhattan Borough Sewers

By William Goldsmith*

SYNOPSIS—Besides disposing of 800,000 cu.yd. of snow by means of the sewers in 1914 the Borough of Manhattan, New York City, made a hundred detailed observations in the sewers receiving the snow. These are presented in tabular form, arranged by size of sewers and giving theoretical velocity of sewage and actual velocity of snow, besides other data.

The sewers of Manhattan Borough were used to a greater extent for the disposal of snow during the winter of 1914 than in any previous year. Approximately 800,000 cu.yd. of snow were dumped by carts into sewer manholes instead of being hauled to the river front, as is the usual method. [See accompanying views of (1) hauling, (2) shoveling and (3) dumping snow into sewer manhole and (4) dumping at waterfront.]. Every facility of the Manhattan Bureau of Sewers was offered to the Street Cleaning Department in order to expedite the removal of snow.

In order to determine to what extent the sewers of Manhattan Borough could be used for snow removal, a series of experiments were conducted during the winter of 1914. The experiments may be divided into five parts:

(1) Obtaining the actual weight of snow.
(2) Noting the effect of sewer water on snow.
(3) Noting the effect of dumping snow into sewer siphons.
(4) Noting the effect of dumping snow into sewers of different sizes and velocities.
(5) Costs.

Weight of Snow

From the "American Engineer's Handbook" we find that freshly fallen snow weighs from 5 to 12 lb. per cu.ft. Compacted or wet snow weighs from 15 to 50 lb. per cu.ft.

By an actual test it was found that compacted snow as carried in wagon loads during 1914 weighed 36 lb. per cu.ft. This last weight was obtained by test on an average sized New York wagon into which snow was shoveled. This does not give the actual weight of a compacted cubic foot, but is the cubic foot which includes voids as they exist in the average wagon load. The test obtaining this weight was made on March 20, an average wagon load being weighed on an ordinary coal scale. The snow which was shoveled into the wagon consisted of chunks about 18x18x12 in. and weighed from 10 to 20 lb. per piece. The atmospheric temperature was about 25° F. The weight of the wagon and snow was 7700 lb.; of the wagon empty, 4150; of the snow, therefore, 3550. The cart carried 4 cu.yd. of snow, thus giving 888 lb. as the weight of a cubic yard of snow in the wagon. This weight is used as a basis in what follows.

Effect of Sewer Water on Snow

In order to determine how quickly snow melts when it comes into contact with sewer water, an actual test was made in the Manhattan Ave. sewer between 121st and 122nd streets. A cake of snow well compacted was weighed, dropped into one sewer manhole, picked up by a man at the next manhole and re-weighed. The temperature of the water in the sewer was 60° F.; depth of water, 12 in.; size of sewer, 5x4 ft.; velocity, approximately 3 ft. per sec.; distance between manholes, 250 ft.; time for snow to travel from one manhole to the next, 85 sec. Three separate cakes of snow were dropped at intervals of approximately five minutes, the test resulting as follows:

Weight of snow before being dropped into manhole	Weight of snow when picked up at second manhole
8 lb. 7 oz.	6 oz.
9 lb. 8 oz.	11 oz.
13 lb.	1 lb. 1 oz.

By a simple proportion we have:

Actual distance between manholes : distance necessary to melt snow : : last weight : total weight.

This gives 262 ft. as the point where the first piece of snow would be entirely melted; 269 ft. for the second, and 272 ft. for the third. From this, it may be safely assumed that within 300 ft. no snow would be left.

There is a possible inaccuracy in the above simple proportion for the reason that as the snow is melted the mass becomes smaller and the area in contact with the sewer water is diminished.

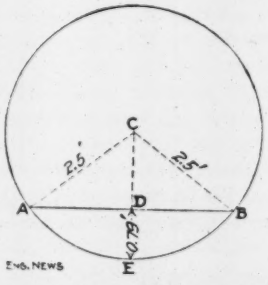
The compacted snow used in this test was the largest which could be obtained, it having laid on the streets for nearly a month, and was more like ice than snow. Thus, this was a more severe test than would have been the case had freshly fallen snow been used.

Lenox Avenue Sewer Experiment—To determine to what extent the temperature of sewer water was affected by the continual dumping of snow therein, and whether, theoretically, there was sufficient heat present to melt the snow, an experiment was tried on the Lenox Avenue sewer between 114th and 115th streets, thus:

Size of sewer, 5 ft. circular.
Depth of water, 9½ in.
Velocity (actual), 2.6 ft. per sec.
Temperature of sewer water, 60° F.
Temperature of sewer water below point of snow dumping, 54° F.

$$Q = A V$$

Q = Cu.ft. of water passing this point in 1 sec.;
A = Area of water section in sq.ft.;
V = Velocity in feet per sec.
A = ⅔ middle ordinate × chord.



D E = 9½ in. = 0.79 ft.
C D = 2.5 — 0.79 = 1.71
then A D
$= \sqrt{CA^2 - CD^2}$
$= \sqrt{2.5^2 - 1.71^2}$
$= \sqrt{3.33} = 1.82$
then
A B = 2 × 1.82 = 3.64 ft.
A = ⅔ × 0.79 × 3.64 = 1.92 sq.ft.
Q = 1.92 × 2.6 = 4.99 cu.ft. per sec., or say 5,
5 × 60 = 300 cu.ft. per min.
300 × 62.5 = 18,750 lb. of water per min.

The rate at which snow was shoveled into this sewer was obtained thus: Two wagon loads were dumped beside the manhole; then four men took just eight minutes to

*Department of Public Works, Borough of Manhattan, 1640 Concourse, The Bronx, New York City.

FIGS. 1-4. SNOW DISPOSAL INTO SEWERS AND AT WATER FRONT, NEW YORK CITY

(1) Hauling the snow to a sewer manhole. (2) Shoveling snow into manhole. (3) Dumping snow directly into sewer manhole. (4) How snow is dumped at the water front.

shovel it all into the sewer. So we have two wagon loads × 3550 lb. (previous test) = 7100 lb. shoveled into the sewer in eight minutes, giving a rate of 888 lb. of snow entering the sewer per min.

It takes 144 B.t.u. to change 1 lb. of snow or ice into water; therefore, 888 × 144 = 127,782 B.t.u. would be required for these 888 lb. per min.

The temperature of snow is approximately 32° F.; the sewer water was 60° F., which is 28° above that of the snow.

Since 18,750 lb. of water passes per min., we get 18,750 × 28 = 525,000 B.t.u. available to melt this snow; whereas, it is shown above that only 127,872 B.t.u. are necessary.

A man standing in the sewer 127 ft. from where the snow was dumped, found the sewer-water temperature to be an average of 54° F., giving a drop of 6° from the normal temperature of the water. This gives a theoretical expenditure of 18,750 lb. × 6° = 112,500 B.t.u., which is slightly less than the theoretical 127,872 B.t.u. necessary for the entire melting of the snow. It was observed, however, that a few small pieces of snow were still intact at this point, which explains the reason for this theoretical figure.

At a manhole 264 ft. from the dumping point no snow remained, but the temperature of the water was normal; i.e., 60° F. This experiment shows that there was almost four times as much heat in this sewer as is needed to melt all the snow dumped therein, within 200 ft., and the theoretical amount of heat used in melting the snow checks up the actual amount very closely, showing that gases and chemical combinations must not be considered in this connection.

EIGHTY-FIRST STREET SEWER EXPERIMENT — More snow was dumped into the 81st St. sewer between Broadway and West End Ave., during March, 1914, than into any other sewer. This is a 6-ft. circular sewer and had 16 in. of water flowing in it on March 15, with a velocity of 4 ft. per sec. On this day 640 loads of snow were dumped into three manholes within this block during eight hours. This gives 5 cu.yd. per min. of snow dumped into the sewer. Five men were used at each manhole to shovel the snow dumped from the carts. A quick test at one of these holes showed that it took 30 sec. to empty a load containing 4 cu.yd. into the sewer, this giving 32 sec. per cu.yd., which is the quickest record obtained throughout these experiments and indicates a probable limit with which it is possible to empty snow into the sewer manholes.

This sewer turns south on Riverside Drive and enters the Hudson River at 80th St., a distance of approximately 1000 ft. Observations made at this outlet while the snow was being dumped into the manhole at the maximum rate showed no indication of snow at this point.

TIDAL SEWER EXPERIMENTS—Many sewers in Manhattan Borough are affected by the tides; that is, the water rises in them with the incoming tide and is entirely clear of tidal water when the tides are low. Some of these were used for snow removal, but it was found that some clogged up and that the snow did not melt, but would come out at the outlet in large chunks. This was probably due to the low temperature of the tide water bringing the sewage temperature much lower than is ordinarily the case. These observations would indicate that sewers affected by the tides cannot be used to advantage at all times.

Tests of Siphon Sewers

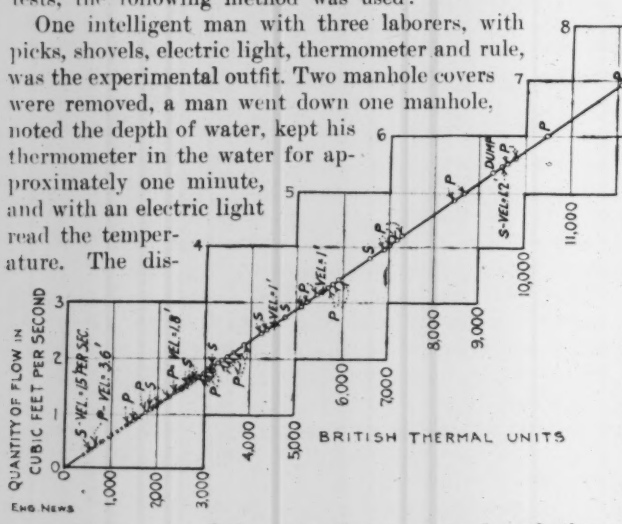
At 106th and 110th Sts. are sewers which are intercepted by the Lexington Ave. subway. At these points siphons were constructed by the Public Service Commission, and it was thought that these might clog up if snow was dumped into the sewers above the siphon points.

At 110th St., 117 ft. west of the west curb line of Lexington Ave., there is a manhole which is practically the start of the siphon underneath the subway. At this point 23 men dumped snow into the sewer as quickly as possible. (This is a more severe test than a wagon dumped directly into a manhole.) Most of the snow consisted of large chunks. Observations at a manhole 274 ft. from this point at the other end of the siphon showed practically no trace of snow. Some of the large chunks appeared reduced approximately to one-quarter of their size, but no trouble was found with the working of these siphons. Practically the same results were obtained at the 106th St. siphon, from which may be deduced that sewer siphons of this type, when other conditions are favorable, can be used with perfect safety for the disposal of snow.

Actual Tests on Sewers of Various Sizes and with Different Velocities

In order to lay down some general rules to determine which sewers can be used for the removal of snow, experiments were made on different sized sewers with different velocities at various locations. In making these tests, the following method was used:

One intelligent man with three laborers, with picks, shovels, electric light, thermometer and rule, was the experimental outfit. Two manhole covers were removed, a man went down one manhole, noted the depth of water, kept his thermometer in the water for approximately one minute, and with an electric light read the temperature. The distance between manholes was then measured and the time recorded which it took a float (small piece of wood) to travel from one manhole to the next. A quantity of snow was then taken, quickly shoveled into the manhole and observations made to note whether the sewer clogged or whether the snow was easily carried away. At locations which might be used for dumping wagon loads of snow into the sewer, a wagon load was secured and a direct test made. If no wagons were available, an immense heap of snow was gathered about the manholes by the laborers and quickly shoveled in, so that the conditions obtaining when a wagon load was dumped were secured.



In the table on p. 867, under the heading "Remarks," three expressions are used, shoveling, panning, dumping.

"Shoveling" means one or two men shoveling freshly fallen or small pieces of snow into a sewer with care, large lumps not being used, as with these the sewer would clog.

"Panning" means the process of using drag scrapers with a laborer shoving the snow into the manhole, or the drag scrapers with horses attached dumping directly into the sewer.

"Dumping" means the process of dumping wagon loads directly into the sewer manhole.

A statement, as "O. K. for shoveling, panning or dumping" means that it is possible to so use these sewers.

"N. G. for shoveling, panning or dumping" means that it is not possible to so use these sewers.

The experiments shown by the accompanying table were plotted. The results as shown by the accompanying curve (Fig. 5) indicate: (1) that snow can be dumped by wagon loads into sewers carrying 10 cu.ft. per sec. or more; (2) that panning can be employed where sewers have 3 cu.ft. per sec. or more flowing in them

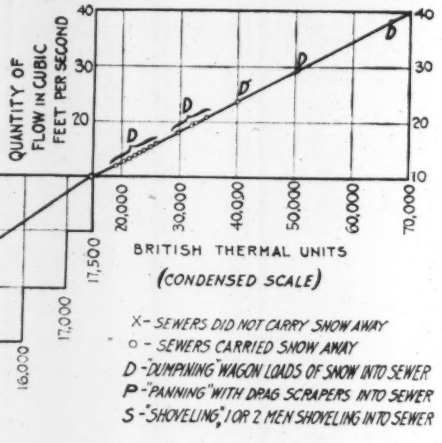

QUANTITY OF FLOW IN CUBIC FEET PER SECOND
BRITISH THERMAL UNITS
(CONDENSED SCALE)
X - SEWERS DID NOT CARRY SNOW AWAY
O - SEWERS CARRIED SNOW AWAY
D - "DUMPING" WAGON LOADS OF SNOW INTO SEWER
P - "PANNING" WITH DRAG SCRAPERS INTO SEWER
S - "SHOVELING" 1 OR 2 MEN SHOVELING INTO SEWER

Fig. 5. Sewage Thermal and Volume Curve, New York Experiments on Snow Disposal by Sewers

(For details see accompanying large table. Average temperature of sewage, 60° F.; of snow, 32° F.)

and where the velocity is greater than 1½ ft. per sec.; (3) that snow can be shoveled into sewers having 2 cu.ft. per sec. flowing in them if the velocity is greater than 1½ ft. per sec. The above statement will probably hold if a sufficient depth of water exists.

In some cases, experiments showed that where the velocity was great and the flow small, much snow could be carried away; so in the 110th St. sewer, between Manhattan and Columbus avenues, we have a flow of 5.3 cu.ft. per sec., the velocity being, however, 10 ft. per sec. Yet with this slight flow this sewer makes an excellent dump.

A study of the curve (Fig. 5) will show that the above conclusions are conservative and that sewers outside of these limits may be used, but it is recommended that they should not be unless tried out by actual test in each case.

Costs

Very important items to consider when it is proposed to use sewers for snow disposal are:

(a) Cost of necessary inspection.
(b) Removal of silt and other matters which are dumped in with the snow.
(c) Possible damage suits arising from clogged-up sewers.

OBSERVATIONS TO DETERMINE WHETHER SEWERS COULD BE USED TO REMOVE SNOW IN NEW YORK CITY.

Location	Size of sewer, ft. and in.	Depth of sewage, in.	Discharge, cu.ft. per sec.	Temp. sewage, deg. F.	Distance, ft.	Time sec.	Velocity, ft. per sec. Theoretical	Velocity, ft. per sec. Actual	Remarks
Lenox Ave., 114th to 115th St., W. S.	5 cir.	9½	15.6	60	264	100	2.9	2.6	O.K. dumping
81st St., B'way to West End Ave...	6x6	16	19.7	60	220	60	4.8	4.0	Excel. dump
75th St., Amst. to Col. Ave.....	5x4 ell	18	10.1	52	?	?	2.8	?	O.K. panning
B'way, E. S., 96th to 102d St.....	5-6x5 / 4x2-8	3½	5.8	58	200	90	3.1	2.0	O.K. panning
98th St., Col. to Amst. Ave.....	5-6x5	11	14.2	54	150	55	3.9	2.7	Good dump
98th St., Amst. to B'way.....	5-6x5	10	14.8	54	125	60	3.6	2.1	Good dump
83d St., Col. to Amst. Ave.....	5-7¼x5	10	12.3	49	250	80	3.2	3.1	Good dump
96th St., Amst. to B'way.....	5-6x5	5	36.5	57	120	10	12.0	12.0	Excel. dump
124th St., 7th to 8th Ave.....	5-7½x5	8½	16.0	62	150	110	2.3	1.4	O.K. dumping
Manhattan Ave., 116th to 124th St..	5x4	14	19.2	57	200	70	3.8	2.9	O.K. dumping
1st Ave., E. S., 100th St. to 106th St..	4-6x5	16½	12.0	64	125	Slow	3.1	...	O.K. dumping
106th St., Lex. to 2d Ave.....	5-7½x5	6	29.7	60	160	30	2.7	5.3	O.K. dumping
110th St., Lex. to 2d Ave.....	8x12	16	57.0	60	280	45	2.6	6.2	O.K. dumping
110th St., Lenox to 5th Ave.....	6-6 cir.	16	21.6	60	200	40	4.4	5.0	O.K. dumping
110th St., Madison to Park Ave....	8x12	16	46.0	60	200	40	2.6	5.0	O.K. dumping
75th St., Amst. to Col. Ave.....	5x4 ell	12	11.1	54	150	100	3.2	1.5	O.K. dumping
70th St., West End to Amst. Ave...	5x4	14	23.6	61	100	35	3.5	2.8	O.K. dumping
Sewers between 4 and 5 ft.									
118th St., 3d to 2d Ave.....	4x2-8	6	7.0	55	100	100	1.7	1.0	O.K. shovel
Cent. Pk. W., 100th to 103d St.....	4x2-8	3½	3.2	48	250	150	1.05	1.6	O.K. panning
Amst. Ave., 96th to 104th St. (2)....	3x4	6	E. S. 9.5 W. S. 5.4	56	100	65	3.1	1.2	O.K. panning
98th St., Cent. Pk. W. to Col. Ave....	4x2-8	4	4.9	60	120	30	3.4	4.0	O.K. panning
100th St., Cent. Pk. W. to Col. Ave..	4x3 / 5x4	10	5.4	65	175	155	2.4	1.2	O.K. shovel
110th St., Manhattan to Col. Ave....	4x2-8	3½	5.3	64	200	20	5.3	10.0	Excel. dump
West End Ave., 87th to 88th St.....	4x2-8	5	2.7	61	125	75	4.1	1.7	O.K. panning
88th St., Cent. Pk. W. to Col. Ave....	4 cir.	11	3.3	59	100	50	3.2	2.0	O.K. panning
Lenox Ave., E. S., 116th to 121st St..	4x2-8	6½	6.0	44	125	75	2.3	1.6	O.K. panning
Lenox Ave., W. S., 116th to 121st St..	4-6x4	7	7.5	57	125	70	2.5	1.7	O.K. panning
121st St., Lenox to 7th Ave.....	4-6x4	5½	4.8	53	175	100	2.15	1.7	O.K. panning
5th Ave., 125th to 135th St.....	4x2-8	5	16.5	52	100	45	1.65	2.2	O.K. panning
109th St., 1st to 2d Ave.....	4x2-8	4	1.4	62	200	165	1.6	1.3	O.K. shovel
108th St., 1st to 2d Ave.....	4x2-8	4	1.8	45	100	95	1.6	1.0	O.K. panning
2d Ave., W. S., 100th to 106th St.....	3-6x2-4 / 4x2-8 / 4x3	11	3.3	50	125	200	2.65	0.6	O.K. dumping
95th St., 2d Ave. to East River.....	4 cir.	16	7.3	60	100	75	2.8	1.2	O.K. dumping
106th St., Mad. to Park Ave.....	4-6x4	4	0.8	60	100	100	1.6	1.0	O.K. panning
87th St., Lex. to 3d Ave.....	4x2-8	3	1.1	51	100	110	2.6	1.0	O.K. shovel
86th St., 2d Ave. to East River.....	4x2-8 / 4 cir.	8	16.5	62	100	34	8.5	2.9	O.K. dumping
85th St., Lex. and 3d Ave.....	4x2-8	3	1.4	53	100	Slow	3.2	...	N.G. shovel
65th St., B'way to Amst. Ave.....	4x2-8	9	13.3	60	200	?	5.0	?	O.K. dumping
Sewers between 2 and 3 ft.									
94th St., Cent. Pk. W. to Col. Ave..	3-6x2	2½	0.7	62	100	...	1.5	?	N.G. panning
175th St., Amst. to Audubon Ave. (2)	3-6x2-4	3	N. S. 1.8 S. S. 3.9	55	100	20	4.0	5.0	O.K. panning
92d St., Amst. Ave. to Broadway....	3-6x2	1½	0.3	61	125	55	2.6	2.0	N.G. panning
91st St., Col. to Amst. Ave.....	15 pipe	3	0.6	58	100	40	3.5	2.5	N.G. panning
82d St., Cent. Pk. W. to Col. Ave....	3-6x2	2	0.7	85	...	...	2.3	?	N.G. panning
110th St., Lenox to 8th Ave.....	3-7¼x2-4¾	8	4.1	53	300	120	3.75	2.5	O.K. panning
101st St., Cent. Pk. W. to Col. Ave..	3-6x2 / 15 pipe	1	0.3	54	...	...	1.9	1.5	O.K. shovel
Manhattan Ave., 105th to 107th St..	3-6x2-6	1½	2.7	56	50	10	4.7	5.0	O.K. shovel
B'way, E. S., 110th St. to 112th St..	18 & 15 pipe	3½	2.7	63	110	20	5.5	5.0	O.K. panning
Cent. Pk. W., 96th to 98th St.....	3-6x2-4	6	4.1	64	200	50	4.8	4.0	O.K. panning
Amst. Ave., 79th to 81st St.....	3-6x2	6½	4.4	64	150	50	3.1	3.0	Bet. tracks bad
West End Ave., 78th to 80th St.....	3-6x2	1¾	1.1	63	120	35	1.7	3.4	N.G. shovel
81st St., Cent. Pk. W. to Col. Ave...	3-6x2-4	2½	1.8	81	100	52	1.75	2.0	O.K. panning
82d St., Col. to Amst. Ave.....	3-6x2	5	1.8	79	120	45	3.1	2.7	O.K. panning
86th St., Col. to Amst. Ave.....	3-6x2	2½	1.8	55	100	?	1.5	1.0	N.G. panning
Col. Ave., 88th to 91st St.....	3-6x2	5½	0.4	55	200	56	6.4	3.6	O.K. panning
96th St., Col. to Amst. Ave.....	3-6x2-4	5½	2.9	54	100	75	4.2	1.2	O.K. panning
81st., Col. to Amst. Ave.....	3-6x2	1¼	0.6	69	100	24	2.7	4.0	N.G. shovel
7th Ave., E. S., 112th to 115th St...	3-7¼x2-4¾	3½	0.6	55	125	120	1.2	1.0	N.G. shovel
7th Ave., W. S., 112th to 115th St...	3-7¼x2-4¾	9	4.0	61	130	90	2.9	1.4	O.K. panning
120th St., Lenox to Mt. Morris Pk. W.	3-6x2	2½	1.2	54	125		1.5	1.0	N.G. shovel
8th Ave., 127th to 131st St., W. S....	3-6x2								
8th Ave., 127th to 131st St., E. S.....	18 pipe	4	2.9	42	125	125	1.8	1.0	O.K. panning
125th St., Lenox to 5th Ave.....	3 cir.	3	1.4	53	100	...	2.5	?	N.G. shovel
119th St., 5th to Park Ave.....	3-6x2-4	3½	2.6	55	100	120	2.0	1.0	N.G. shovel
114th St., 1st to 2d Ave.....	3-6x2-4	2¼	1.5	45	100	100	1.45	1.0	O.K. shovel
113th St., 1st to 2d Ave.....	3-7¼x2-4¾	4	1.7	53	100	90	1.9	1.1	O.K. panning
107th St., Park to Madison Ave.....	3-6x2	5½	0.8	55	200	Slow	1.65	?	N.G. panning
105th St., Park to Madison Ave.....	3-6x2	4	1.0	50	125	65	2.8	2.0	O.K. shovel
103d St., Park to Madison Ave.....	3-6x2-4	15	8.1	67	100	40	4.8	2.5	O.K. panning
Park Ave., E. S., 96th to 106th St..	3x2 / 3-7¼x2-4¾	2	4.0	56	100	20	3.5	5.0	O.K. shovel
Madison Ave., 91st. to 103d St.....	3-6x2	4	6.9	60	100	12	5.8	8.0	O.K. panning
5th Ave., 91st to 107th St.....	3-6x2-4 / 3 cir. / 2-6 cir.	4½	6.9	43	125	33	5.5	4.0	O.K. panning
97th St., Lexington to 3d Ave.....	3-6x2	3½	2.5	53	225	...	4.0	?	O.K. shovel
98th St., Lexington to 3d Ave.....	3-6x2	3	0.8	50	125	22	4.9	5.0	O.K. panning
3d Ave., E. S., 98th to 100th St.....	3 cir.	8	8.0	50	125	25	8.3	5.0	O.K. dumping
3d Ave., W. S., 100th to 106th St.....	3x2 / 12 pipe	4	2.4	43	125	50	2.9	2.1	O.K. shovel
93d St., 3d to 2d Ave.....	3-6x2-4	9	1.7	52	75	25	13.0	3.0	O.K. dumping
73d St., Amst. to Col. Ave.....	3-6x2	3	1.7	45	100	22	2.8	4.6	O.K. panning
72d St., Amst. to Col. Ave.....	3-6x2-4	6	1.84	65	100	25	4.8	4.0	O.K. panning
Sewers smaller than 2 ft.									
89th St., Cent. Pk. W. to Col. Ave...	12 pipe	2	0.45	59	100	...	1.7	?	N.G. panning
87th St., Cent. Pk. W. to Col. Ave....	15 pipe	1½	0.70	55	100	75	2.3	1.2	N.G. panning
84th St., Cent. Pk. W. to Col. Ave....	15 pipe	2	0.70	59	100	95	1.6	1.0	N.G. panning
Columbus Ave., 92d to 96th St.....	18 pipe	2	1.4	56	...	...	1.0	?	N.G. shovel
3d Ave., 116th to 118th St.....	18 pipe	2	3.2	43	75	90	1.5	1.0	N.G. shovel
117th St., 1st to 2d Ave.....	15 pipe	3½	1.40	72	75	48	1.8	1.6	O.K. panning
115th St., 1st to 2d Ave.....	18 pipe	5¼	1.60	37	100	45	2.4	2.2	O.K. panning
115th St., 2d to 3d Ave.....	15 pipe	1½	0.65	45	100	100	1.2	1.0	N.G. shovel
111th St., 1st to 2d Ave.....	15 & 18 pipe	3¼	1.3	42	100	100	1.6	1.0	O.K. shovel
91st St., 3d and 2d Ave.....	18 pipe	3	2.1	60	100	20	5.6	5.0	O.K. panning
90th St., 3d and 2d Ave.....	15 pipe	3	2.0	58	100	15	5.5	5.6	O.K. panning
89th St., 3d and 2d Ave.....	18 pipe	2	2.2	51	100	15	4.3	6.6	O.K. panning
88th St., 3d and 2d Ave.....	15 pipe	1¼	0.6	42	125	55	3.2	2.3	N.G. shovel
77th St., Broadway and Amst. Ave..	15 pipe	2½	0.25	60	100	Slow	1.9	...	N.G. shovel
66th St., Broadway and Amst. Ave..	18 pipe	7	1.0	80	100	60	7.0	1.4	O.K. panning

Approximately $400,000 was spent for snow removal into sewers in Manhattan Borough. The inspection cost at sewer manholes was $20,000, approximately, making about 2½c. per cu.yd. of snow dumped. Then, if we assume that 0.5% of snow is dirt or other débris which remains in the sewer or must be removed, we add an additional 3½c. per cu.yd. to the cost, since the removal of dirt in sewers costs approximately $7 a cu.yd. in Manhattan Borough. An estimate of damage suits which may result from the use of sewers for disposal of snow is very difficult. This damage would arise from a clogged-up sewer backing sewage into houses, and possible damage caused thereby.

Conclusions

The results and possible deductions from these experiments may be summarized as follows:

(1) Under ordinary conditions if the flow in a sewer is sufficient to carry the snow away, snow will melt in a sewer within 300 ft. from the point where it is dumped (sewage temperature, 60° F.).

(2) The theoretical number of B.t.u. necessary to melt snow is checked by the tests, showing that gases and chemical combinations have little effect and must not be considered.

(3) The maximum rate at which it is possible to shovel snow into a sewer manhole 24 in. in diameter is 2 cu.yd. per min.

(4) Sewers affected by the tides can only be used to advantage (if other conditions are favorable) when the tide is low.

(5) When other conditions are favorable, siphon sewers will carry snow away just as well as others.

(6) Inspection at each manhole where snow is being dumped is necessary, in order that the sewers shall not clog.

(7) Cost of inspection, removal of silt and possible damage must be considered before determining whether a sewer should be used for snow disposal.

The consulting engineer of Manhattan Borough is E. P. Goodrich; the engineer in charge of sewers, C. E. Gregory. The experiments described in this article were conducted by the writer, under the supervision of the engineers just named.

*

A Working Formula for Eccentric Riveted Connections

By David Kaplan*

The writer has long felt the lack of a simple formula for the number of rivets required in an eccentric connection, expressed in terms of working quantities. The following is the derivation of such a formula for connections having any number of equal rivet lines.

In Fig. 1, let S_m be the bending shear on the extreme rivet due to the moment WL, S_d the shear in the rivet due to the direct load W, and S_r their resultant, equal to the allowable rivet stress. Resolving S_m into its components with respect to XX and YY, we have

$$S_x^2 + (S_y + S_d)^2 = S_r^2$$

or,

$$S_m^2 + 2\,S_y S_d + S_d^2 = S_r^2 \qquad (1)$$

If now in Eq. (1) expressions be found for S_m, S_d and S_y involving the number of rivets as an unknown, it can be solved for the unknown. Thus we would have a general expression for the number of rivets required in an eccentrically loaded connection of any number of equal rivet-lines.

The bending stress in the extreme rivet is:

$$S_m = \frac{WLc}{I_p} \qquad (2)$$

where c is the distance of the extreme rivet from the center of gravity of the rivet-group O, and I_p is the polar moment of inertia of the rivets about O.

To derive I_p directly in terms of the squares of the rivet distances from O is a process both tedious and unnecessary for our final results. But it is a principle of

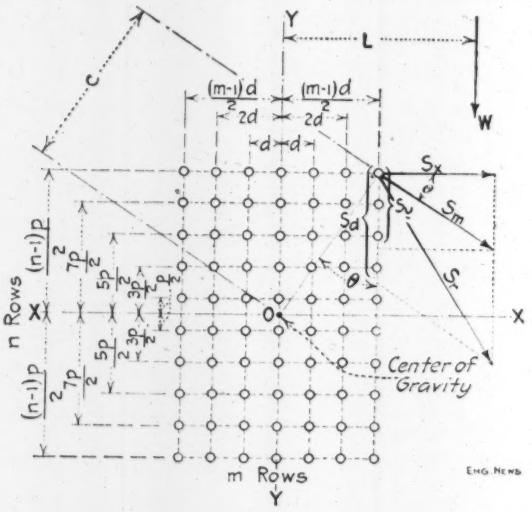


Fig. 1.—Rivet Group of m n Rivets, under Eccentric Loading

mechanics that the polar moment of inertia of a plane about a point is equal to the sum of the moments of inertia about any two axes intersecting at right angles at that point, i.e.,

$$I_p = I_x + I_y \qquad (3)$$

The moment of inertia about either axis is equal to the moment of inertia of one of the lines running normal to it times the number of such lines in the group. If n is the number of rivets in a vertical line, p their vertical spacing and m the number of such lines in the group, then (see Note at end of article):

$$I_x = \frac{mn}{12}(n^2 - 1)\,p^2 \qquad (4)$$

Similarly, if d is the distance between vertical rivet lines, or the horizontal rivet spacing, then:

$$I_y = \frac{mn}{12}(m^2 - 1)\,d^2 \qquad (5)$$

Hence Eq. (3) becomes:

$$I_p = \frac{mn}{12}[(n^2 - 1)\,p^2 + (m^2 - 1)\,d^2] \qquad (6)$$

which is a true formula for the polar moment of inertia of any group of equal rivet lines about their center of gravity.

*Bridge draftsman, Public Service Commission, 154 Nassau St., New York City.

If now in the above equation we substitute for $(n^2 - 1)$ its closely approximate value n^2, and similarly m^2 for $(m^2 - 1)$, the modified value of n will not differ from the true value by more than a fraction. Since the value of n is sought to the nearest integer such substitution is valid for all practical purposes. This is also sustained by the satisfactory results obtained from the final formula. The change gives:

$$Ip = \frac{mn}{12}(n^2p^2 + m^2d^2) \qquad (7)$$

Similarly, the true value of c, which is

$$\tfrac{1}{2}\sqrt{(n-1)^2p^2 + (m-1)^2d^2}$$

becomes modified to

$$c = \tfrac{1}{2}\sqrt{n^2p^2 + m^2d^2} \qquad (8)$$

Hence the expression for Sm becomes:

$$Sm = \frac{6WL}{mn\sqrt{n^2p^2 + m^2d^2}} \qquad (9)$$

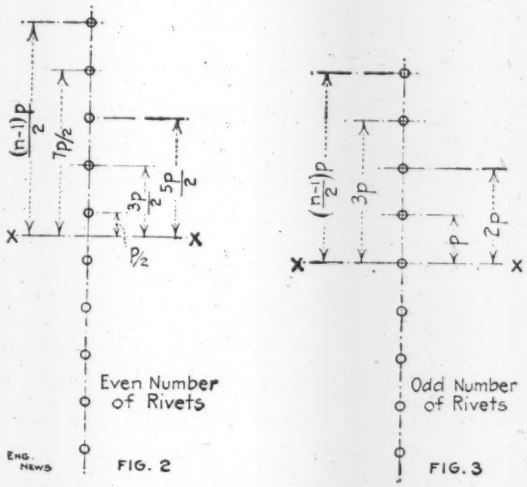


FIG. 2

FIG. 3

Since the direction of Sm is normal to c, we have the relation:

$$\frac{Sy}{Sm} = \frac{(m-1)d}{\sqrt{(m-1)^2d^2 + (n-1)^2p^2}}$$

or approximately

$$\frac{md}{\sqrt{n^2p^2 + m^2d^2}}$$

Hence

$$Sy = \frac{6WLd}{n(n^2p^2 + m^2d^2)} \qquad (10)$$

Since the total number of rivets (Fig. 1) equals mn, the direct stress Sd is:

$$Sd = \frac{W}{mn} \qquad (11)$$

Now substituting in Eq. (1) the values for Sm, Sy and Sd, and putting $W/Sr = k$, a coefficient, and reducing it to a most convenient quadratic form, we get:

$$\left[\frac{m^2p^2}{m^4d^2 - k^2p^2}\right]n^4 + n^2 = \frac{(6L + md)^2k^2}{m^4d^2 - k^2p^2} \qquad (12)$$

Solving the above equation first for n^2, then for n, and eliminating in the resulting expression the terms unity (1) under each radical sign, which may be done without affecting the final value of n by more than a fraction as reasoned above, and by proper cancellation, the following convenient working formula is obtained:

$$n = \sqrt{\frac{k(6L + md)}{mp}} \qquad (13)$$

where as a recapitulation:

n = number of rivets required in each line for any group of equal rivet lines;
m = number of rivet-lines employed; group of equal rivet-lines;
L = eccentricity of load;
p = vertical rivet spacing;
d = horizontal rivet spacing, and
k = ratio of load to the allowable rivet stress, or $k = W/Sr$.

The following is a comparison of results obtained by using formula (13) with the actual required values of n as obtained by directly computing the squares of the rivet distances in each case.

k = W/Sr	L, in.	m	p, in.	d, in.	Required number of rivets by computation	n, by eq (13)
3.00	6.0	1	3	0	6	6.00
8.00	18.0	2	3	3	12	12.32
10.00	21.0	3	3	3	12	12.21
9.5	18.0	4	3	3	9	9.74
22.72	10.0	5	4	3	9	9.23

NOTE—The expression for moment of inertia of one rivet-line, about a central axis normal to the rivet-line, is the same for even as for odd number of rivets.

For *even* number of rivets, n, Fig. 2, the moment of inertia I_x is:

$$I_x = 2p^2\left[(\tfrac{1}{2})^2 + (\tfrac{1}{2}+1)^2 + (\tfrac{1}{2}+2)^2 + \ldots\left(\tfrac{1}{2} + \frac{n}{2} - 1\right)^2\right]$$

$$= 2p^2\,[\tfrac{1}{4} + \tfrac{1}{4} + 1 + 1^2 + \tfrac{1}{4} + 2 + 2^2 + \tfrac{1}{4} + 3 + 3^2 + \tfrac{1}{4} + \left(\frac{n}{2} - 1\right) + \left(\frac{n}{2} - 1\right)^2]$$

For $\frac{n}{2}$ terms the sum $\Sigma\,\frac{1}{4}$ is $\frac{n}{8}$; the sum of the arithmetical progression $1 + 2 + \ldots\left(\frac{n}{2} - 1\right)$ is $\frac{n}{8}(n-2)$; the sum of the series of squares $1^2 + 2^2 + 3^2 \ldots \left(\frac{n}{2} - 1\right)^2$ is, calling N^2 the last term, $\frac{N}{6}(N+1)(2N+1)$, and substituting $\left(\frac{n}{2} - 1\right)$ for N, the sum is $\frac{n}{24}(n-1)(n-2)$

Hence,

$$I_x = 2p^2\left[\frac{n}{8} + \frac{n}{8}(n-2) + \frac{n}{24}(n-1)(n-2)\right]$$

$$= \frac{n(n^2-1)p^2}{12}$$

For an *odd* number of rivets, Fig. 3, if we still denote the number of rivets by n, we have:

$$I_x = \left[1^2 + 2^2 + 3^2 + \ldots\left(\frac{n-1}{2}\right)^2\right]$$

which, by the summation formula $\frac{N}{6}(N+1)(2N+1)$, becomes

$$I_x = 2p^2\left[\frac{(n-1)(n+1)n}{24}\right] = \frac{n(n^2-1)p^2}{12}$$

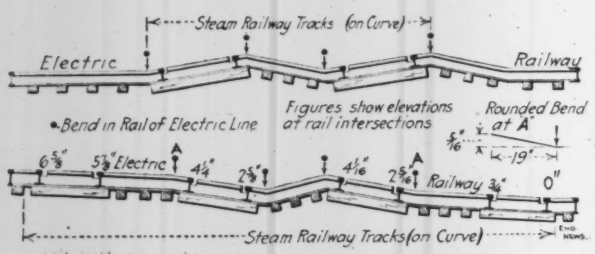
Thus the expressions for I_x are identical for odd and even number of rivets.

Track Crossings on Curves, with Superelevation

A special problem in track-crossing construction is involved in carrying an electric railway at grade across a steam-railway track when the latter is on a curve and has superelevation of the outer rails to provide for fast trains. This problem was suggested in our issue of May 21, by a correspondent who inquired as to a means by which superelevation may be introduced where one of the intersecting tracks is on a curve, so that trains may pass the crossing at high speed.

An arrangement to meet this condition seems to have been introduced in a number of cases where a steam railway (on curve) had to be crossed by an electric railway. Mr. Hain, Superintendent of Construction of the Altoona & Logan Valley Electric Ry., wrote us as follows on this subject:

> About 13 or 14 years ago, the Atlantic City R.R. crossed the electric railway tracks of the Camden & Suburban E. R. Co. with a rather sharp curve, perhaps 5 or 6°, and with about 6 in. of elevation. The crossing was about 45°. Train speed was up to about 30 miles per hour. Owing to length of time since observing the crossing, the details are not fully remembered. To get the condition given, the electric railway portion of the crossing was of a profile somewhat as shown in the accompanying cut, the end and intermediate rails being bent at the mills to get the profile required. My recollection was that the crossing was fairly good for the steam track, but rather jolting for the electric railway, part of this being due to the angle of crossing.



PROFILES OF ELECTRIC RAILWAY TRACKS AT GRADE-CROSSINGS OF STEAM RAILWAYS ON CURVES, WITH SUPERELEVATION OF OUTER RAILS. (NOT DRAWN TO SCALE)

The crossing in question appears to have been changed or eliminated, as inquiries of the officials of the railways named have failed to locate it or bring any information concerning it. But William Wharton, Jr., & Co., of Philadelphia, advise us that they have furnished crossings of this type for other locations, where the steam track is on a curve, the street-car rails being bent in surface to conform to the irregular cross-section of the curved track (with superelevation of outer rails). The construction is shown diagrammatically in the accompanying cut.

One of these cases is the 51° crossing of a single-track line of the Boston Elevated Ry. with the double-track line of the Fitchburg Division of the Boston & Maine R.R. at Mt. Auburn St., Watertown, Mass. The electric line is on a curve of 1257.6 ft. radius, and the steam line on a curve of 1340-ft. radius. The crossing was built of 85-lb. rails, connecting with the 76-lb. rails of the steam track and 117-lb. 8⅞-in. grooved rails on the electric track. This crossing was built in 1907.

Here the section is as shown in the upper drawing, the maximum superelevation being about 2 in. The rails are bent at four points as shown. The bend is rounded and the baseplates under the rail intersections are bent to fit the rails. The total length of crossing on the electric track is about 50 ft. The flangeways are 2 in. deep, 2 in. wide for the steam tracks and 1½ in. wide for the electric track.

Another case is the 74½° crossing of the Schuylkill Valley Traction Co. (single track) over the four-track line of the Philadelphia & Reading R.R. at DeKalb St. Bridgeport, Penn. The steam railway is on a curve of about 3437-ft. radius on center line, with elevations as shown by the lower drawing. The electric railway is on tangent, with a length of about 53 ft. over the crossing. The entire crossing is built of 90-lb. rails, connecting with 6-in. 60-lb. step-head rails of the electric railway.

The rails are given a rounded bend as shown: the two outer bends give a difference in elevation of $\frac{5}{16}$ in. in a length of 19 in.; the two inner bends give 1¾ in. in the same distance. This crossing had no baseplates under the rail intersections. It may be noted that the electric line (like several others in Pennsylvania) has a gage of 5 ft. 2½ in.

The Use of Electric Energy in the Construction of the Sun River Irrigation Project

By H. N. Savage*

The Sun River Irrigation Project, which is being constructed by the U. S. Reclamation Service, is located in Teton, Lewis and Clark, Chouteau, and Cascade Counties, Montana. Over 300,000 acres of land can be irrigated under this project, provided adequate water-supply can be developed and extension of the project to its ultimate limits is found to be justifiable from an economic standpoint.

Present development of the project (see Fig. 1) includes only the Fort Shaw unit, covering 17,000 acres of land on the south side of Sun River, mainly in the abandoned Fort Shaw military reservation, and about 90,000 acres on the north side of the river in Spring Valley and on the Greenfields bench. These lands will be irrigated by the flow of Sun River, supplemented by stored waters released from Pishkun and Willow Creek reservoirs. The canal system for the Fort Shaw unit was completed in 1908 and has been in operation since that date. The first development of Willow Creek reservoir to impound 19,000 acre-feet has also been completed.

The Sun River diversion dam, 140 ft. in height, located in the narrow Sun River cañon, will divert water to both Pishkun and Willow Creek reservoirs. This dam and the short diversion tunnel leading from the dam to the head of the Pishkun reservoir supply canal are now under construction by government forces. Contract work is also well under way on the Pishkun reservoir supply canal, which has a length of 14 miles and a capacity for the first development of 1250 sec.ft., and on the Sun River slope canal with a length of 31 miles and a capacity for the first development of 500 sec.ft. The contracts provide for the construction of the canals complete including all structures. Location of the distribution system for the Greenfields unit is completed and plans are well advanced toward the construction stage.

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The complete irrigation plan of the Sun River project provides for the storage of water (1) in a reservoir on the North Fork of Sun River, which is to have a capacity of about 350,000 acre-ft., requiring a masonry dam over 300 ft. high; (2) in the Willow Creek reservoir, capacity at final development, 86,000 acre-ft., and (3) in Pishkun reservoir, 46,000 acre-ft. There is also a possibility of storage in connection with further development in Muddy Creek reservoir near Power, and in Benton Lake reservoir 8 miles north of Great Falls. Diamond-drill borings have been completed at the site of the Sun River storage dam, but its construction has not yet been authorized as the Pishkun and Willow Creek reservoirs will furnish sufficient storage for the units of the project now built and under construction.

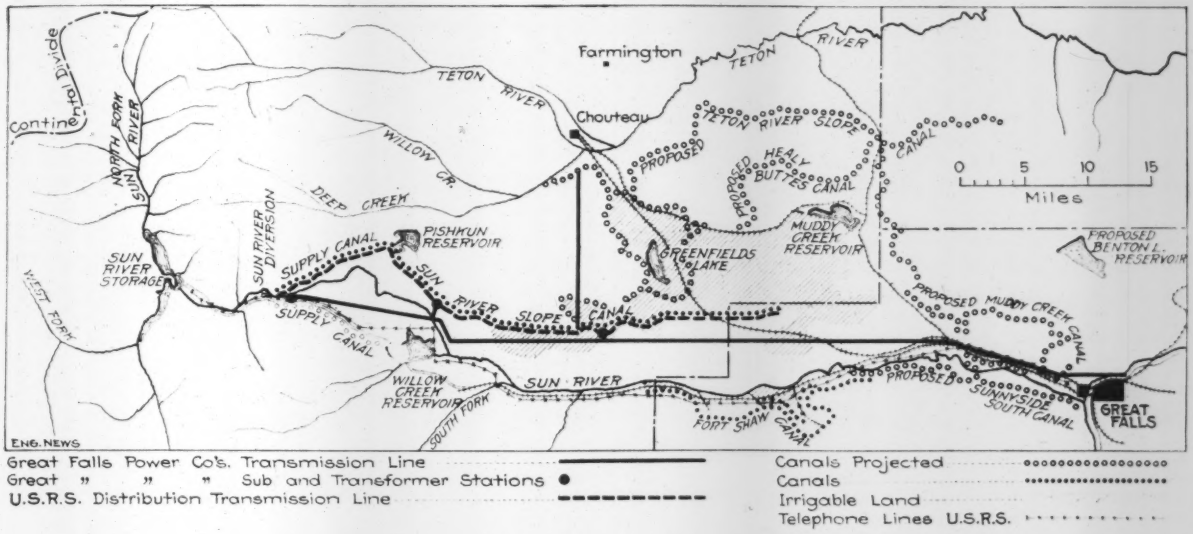


FIG. 1. GENERAL MAP OF THE SUN RIVER PROJECT WORKS

Adequate transportation facilities were a necessary preliminary to construction and a controlling factor in the project's feasibility. These have recently been provided in the construction of several new railway lines through the project. The Great Northern Ry. has completed a branch line from Vaughn station running westerly 40 miles up the Sun River valley to Gilman. The same company has completed and established train service upon a branch line from Power station northwesterly through the project to Chouteau and continuing northwesterly. The Chicago, Milwaukee & St. Paul Ry. has also completed a roadbed northwesterly across the project to Chouteau and beyond, and train service will soon be inaugurated.

As a further prerequisite to the largest success of the project settlers and the most economical construction of the project works, contract was entered into between the United States and the Great Falls Power Co. for electrical energy to be used primarily in constructing the irrigation system, including dams, canals and tunnels and all canal structures, and, ultimately, to insure the availability of electrical energy for the 12 small towns now scattered through the project (which were in existence before the project was put under construction) as well as for about as many more new towns projected along the new lines of railway.

This contract provides for the construction, by the power company, of over 100 miles of trunk transmission line. Starting from the company's Rainbow Falls hydro-

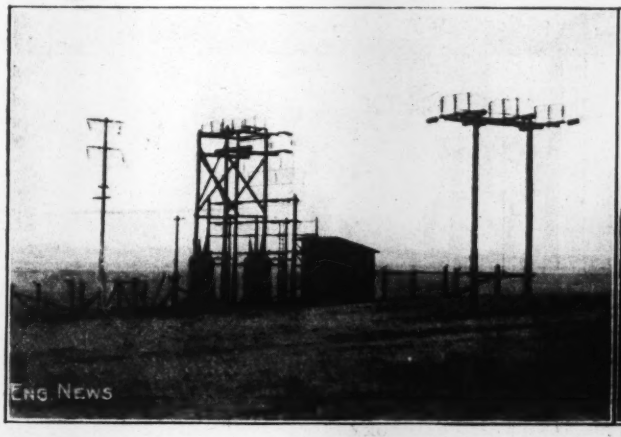


FIG. 2. SUN RIVER SUBSTATION NO. 2 OF THE GREAT FALLS POWER CO.

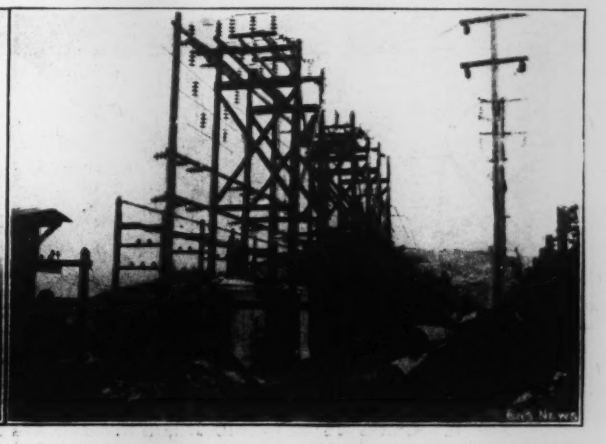


FIG. 3. SUBSTATION NO. 3, SUN RIVER PROJECT
(Pole at right carries the 48,600-volt circuit.)

electric plant, located on the Missouri River about 4 miles below the city of Great Falls, the main transmission line extends westerly through the project for a distance

FIG. 4. SWITCHES AND 15-KW. TRANSFORMER (16,500 TO 2200 VOLTS); HAYDEN BROS., SUN RIVER CONSTRUCTION WORK

of 75 miles to the Sun River diversion dam where the Willow Creek reservoir supply canal and the Pishkun reservoir supply canal divert from the river. A right-angle branch trunk-transmission line, 30 miles in length, will be extended from a point 40 miles west of Great Falls across the project to Chouteau.

The Great Falls Power Co.'s transmission line is strung on wooden poles 45 ft. in length, spaced 300 ft. The energy is delivered to the substation at 48,600 volts, three-phase, 60-cycles. The transmission-line wires consist of three strands of No. 8 B. & S. gage copper. The insulators are of a suspension type. Two wires are suspended from the lower crossarm and one from the upper crossarm. A ¼-in. steel-strand ground wire is strung on one end of the upper crossarm and is grounded at every pole. A telephone circuit, consisting of No. 8 B. & S. copper wire, is placed on the same poles. The transmission line is transposed three times in its total length, and the telephone line is transposed at every fifth pole.

The electrical energy is delivered to the Reclamation Service at three substations; additional substations are to be provided when required. Substation No. 1, located at Mile 45, has a capacity of 600 kw. in two transformers of 300 kw. each; substation No. 2, located at Mile 60, has a capacity of 700 kw. in two transformers of 350 kw. each. Substation No. 3, located at the terminus of the company's transmission line, Mile 75, has a total capacity of 900 kw. in three transformers of 300 kw. each. The transformers in the substation reduce the voltage from 48,600 to 16,500 for local distribution. Substation No. 3 also contains two transformers stepping down from 16,500 to 2500 volts for local use at the diversion dam and tunnels at the upper end of the canal system, where it is used for driving air compressors, hoisting engines, pumps, concrete mixers, ventilating fans, and for lighting and general purposes. Substation No. 3 is equipped with electrolytic lightning arresters on the 48,600-volt side; substations Nos. 1 and 2 have no lightning arresters on the high-tension side. All of the substations are of the outdoor type; but small corrugated-iron buildings are provided at each substation, in which are installed on the low-tension side of the transformers, oil switches and graphic and integrating watt meters.

The government has constructed a 16,500-volt distribution-transmission line the entire length of and adjacent to the Pishkun reservoir supply canal and Sun River slope canal, a distance of 45 miles. The line is strung on wooden poles 30 ft. in length, spaced 150 ft. The distribution-transmission line consists of No. 6 B. & S. copper wire placed on glass insulators. In order to keep this line, throughout its length, convenient to the canal work, the line as constructed is very crooked and required an unusual number of guys and double crossarms. A great number of ravines are crossed, with spans varying from 150 to 450 ft. No ground wire is used on this line. A telephone line is placed on the same poles. At points where the energy is used along the canals and tunnels, portable transformers mounted on skids or on wagons are used to step the voltage down to that required by the contractors. For the dragline-scraper work, the voltage is first stepped down to 2200 and is transmitted through a three-conductor armored cable about 1000 ft. long to the dragline, where it is again stepped down to 440 volts. At the tunnels, direct current at 220 volts is used for drills and is obtained from a 220-volt direct-current generator driven by a 440-volt induction motor.

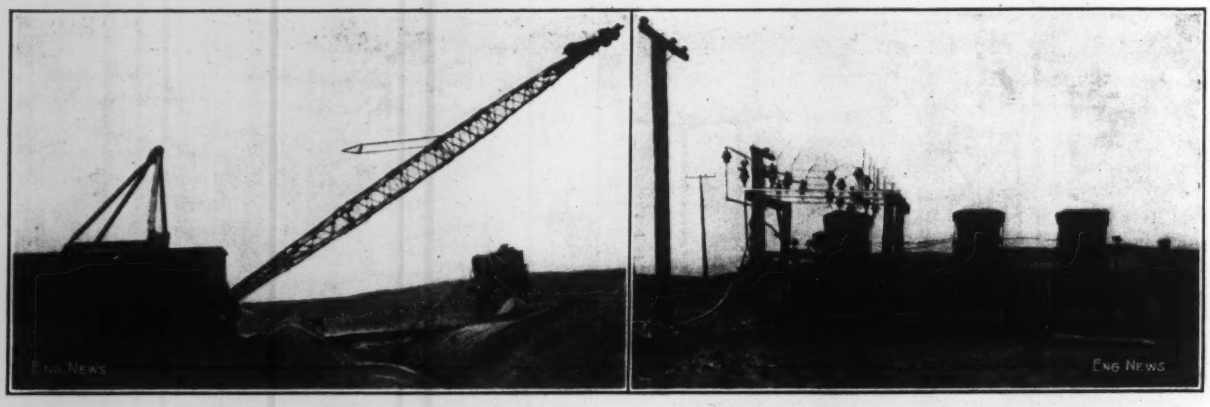


FIG. 5. CLASS 24 ELECTRIC DRAGLINE EXCAVATOR, AND THE TRANSFORMER AND SWITCH WAGONS

The contract specifications for the main canals, Pishkun reservoir supply canal and Sun River slope canal, and for the structures, including tunnels, require that electrical energy shall be used by the contractors for the operation of excavating machinery and wherever else power is used in the construction work covered by the specifications. The United States is to maintain a trans-

mission line adjacent to the canal and furnish the contractor with electrical energy for the operation of the excavating machinery, all power and lighting and other purposes required under the contract.

The contract between the United States and the power company continues over a period of six years and is renewable at the option of the Government. The power company obligates itself to furnish, not to exceed a maximum of 2600 kw., continuous delivery, the United States guaranteeing to pay the company a fixed minimum sum for the total period. Electrical energy is delivered to the contractors at 16,500 volts (measured on the high-tension side of the transformers) at 1c. per kw.-hr., at the substation on the distribution line or at 1.1c., if measured at other points, and there is no service charge. The contractors supply the transformers for stepping down from 16,500 volts and for all lower voltages.

The work covered by the first contract for the construction of the Pishkun reservoir supply canal and Sun River slope canal and Tunnels Nos. 2 and 3, involving the excavation of about 2,400,000 cu.yd. of material and the construction of about 3260 lin.ft. of concrete-lined tunnel, was secured by the MacArthur Bros. Co., of New York and Chicago.

The construction of structures for these same two canals involves about 82,000 cu.yd. of excavation, 14,000 cu.yd. of concrete, the placing of about 664,000 lb. of reinforcing steel, the erection of about 40,000 lb. of structural steel, the placing in wooden structures of about 66,000 ft. b.m. of lumber and the laying of about 24,000 lin.ft. of drain pipe. This contract was awarded to the Hayden Bros. Co., of Portland, Ore. The contractors are now actively engaged in carrying out the construction of the work, utilizing electrical energy wherever power is required.

EXCAVATING MACHINES—Two dragline scrapers were made for the contractors and have been in successful operation for several weeks. The first machine (Class 24 Bucyrus) has a 24-ft.-diameter swing circle, 100-ft. boom and a 3½-yd. extra heavy bucket (Page). The main motor is of 225 hp., and the swinging motor 115 hp. These motors are of a slip-ring induction type, intended for severe intermittent variable-speed reversing service. They are operated by automatic solenoid control, so designed as to make it impossible for the operator to injure the motors by improper handling of his levers, and to make the handling of the electric machines the same as the steam. The excavator is mounted on skids and wooden rollers. The current, which is brought to the machine in a three-wire armored cable at 2200 volts, is transformed in the base of the machine to 440 volts; the motors operate on the three-phase 60-cycle 440-volt current thus supplied.

The second machine (Class 20 Bucyrus) has a turntable of 20-ft. diameter, a boom 85 ft. long and a 2½-yd. extra heavy bucket (Bucyrus). The main motor is of 135 hp. and the swinging motor of 75 hp. The motors and control are of the same design as used on the other machine. This machine is also mounted on skids and rollers, and the current is similarly supplied.

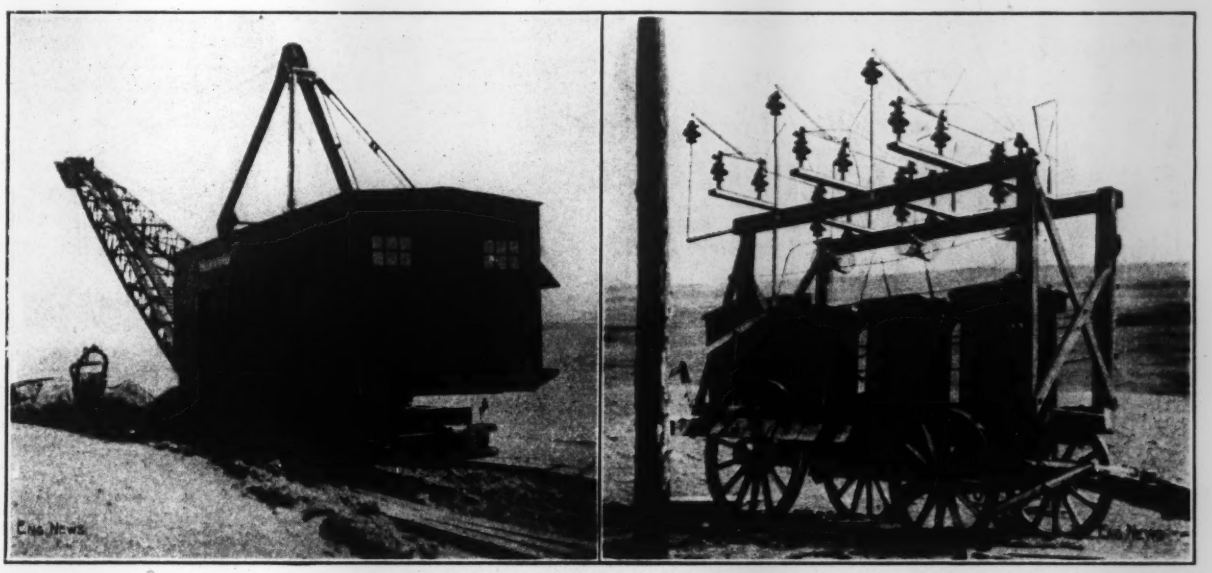


FIG. 6. CLASS 20 ELECTRIC DRAGLINE EXCAVATOR AND THE TRANSFORMER AND SWITCH WAGON

The cost of the energy used by the dragline scrapers has averaged about $0.85 per cu.yd. of material moved.

The Reclamation Service is constructing the diversion dam (which is concrete masonry and is to have a total height of 140 ft.) and Tunnel No. 1, with Government forces, using electrical energy wherever power is required.

*

A Year's Progress on the Lincoln Highway, from New York to San Francisco, gives reason to believe that the undertaking will be carried out successfully without federal aid. About 2500 miles of the total 3400 miles have been marked by the Lincoln Highway Association, and the association has supplied local communities with $40,000 worth of cement to be used in road improvement. In Ohio over three-fourths of the whole has been paved. In Indiana local communities have issued bonds to the amount of $350,000 for improvements not previously contemplated. Sections in Illinois are in the new state-aid road system. In the West much improvement work has been done, particularly in Nebraska, Colorado and Wyoming. The whole highway is in such shape that the transcontinental trip by motor car may easily be made in less than a month.

A Tunneling Machine for Clay or Stiff Sand Formations

A tunneling machine of the boring type, for use in clay or stiff sand and gravel formations, has been in use for some time on a section of the Mount Elliott Ave. sewer in Detroit, Mich., and is now about to be put in operation on the new water tunnel for the City of Cleveland under Lake Erie. The machine was devised by Charles Bonnett of Port Huron, Michigan, a practical tunnel worker who is foreman for the Mount Elliott Ave. sewer work, and is controlled by Carpenter & Anderson, general contractors and engineers, 423 Widdicomb Bldg., Grand Rapids, Mich., and 508 Union Trust Bldg., Detroit. This firm has the contract for Section 2 of the Mount Elliott Ave. sewer, most of which is being excavated with the tunneling machines. The City of Cleveland has leased two of the machines for work on its new waterworks intake, and is to pay a lineal-foot royalty to Carpenter & Anderson for their use. They will be operated by city forces.

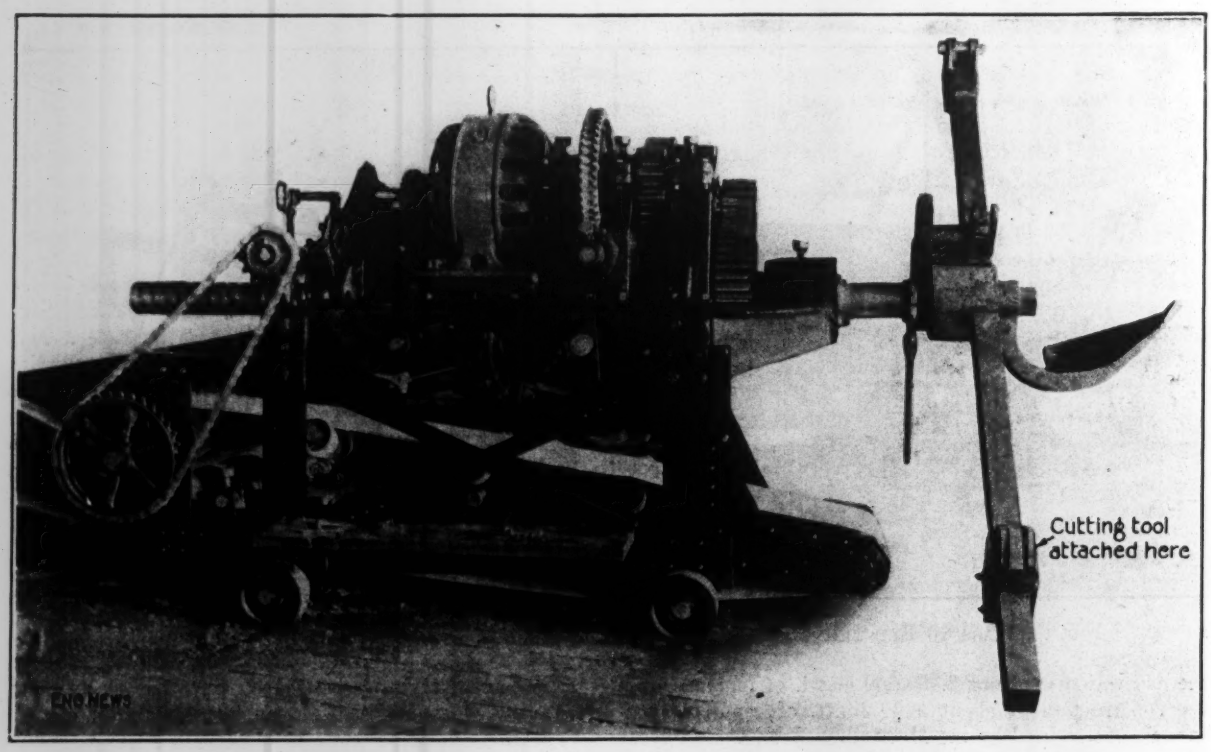


FIG. 1. THE BONNETT TUNNELING MACHINE IN USE ON CLEVELAND WATER-WORKS INTAKE

A view of the machine is shown in Fig. 1 and an outline plan and elevation in Fig. 2. Its essential feature is a horizontal shaft mounted on a movable carriage and centering on the longitudinal axis of the circular tunnel section to be bored. This shaft is geared to an electric motor, and carries at its outer end a boring knife whose point centers in the tunnel face, and a transverse arm which carries a cutting tool. This tool is not mounted directly on the transverse arm, but is fastened to an arm which is parallel to the main arm and is attached thereto by a rack; the rack is geared to the main shaft in such fashion as to drive the cutting tool out along the main transverse arm as the main shaft revolves. That is, the cutting tool makes a spiral cut in the tunnel heading. The machine carriage is further provided with a traveling belt mounted beneath the shaft, leading back to another traveling belt which can be elevated so as to dump into a car.

The operation of the machine is as follows: A full section is first made, by ordinary mining methods, a sufficient distance to allow the entrance of the tunneling machine, which is either mounted on a track or upon some boardway sufficiently elevated to center the main shaft. The plowshare-shaped knife is then centered in the tunnel heading and the machine started. The shaft is so geared that an advance for the full length of the knife, that is, about 15 in., is automatically made, the knife making a conical cut of that depth. The boring knife is then thrown out of gear and the crossarm thrown into gear, and the cutting tool set to work on the edge of the cut made by the knife. The cutting tool is 6 in. deep and 6 in. wide in the diameter of the tunnel, and it automatically proceeds to cut a shaving 6 in. deep and 6 in. wide, progressing from the center hole out to the periphery of the tunnel section, the boring knife serving to center and steady the machine. The shavings so made are picked up by muckers and thrown into the belt conveyor immediately below the shaft, which carries them up to the second conveyor, whence they are dumped into cars and taken back to an outside dump. When the 6-in. cut is made the shaft is thrown out of gear, the carriage advanced 6 in. and the process is repeated.

In the Detroit work, the weight of the machine, together with a number of jacks from the tunnel periphery to the machine were sufficient to take up the reaction of the cut. In fact, the bite of the initial knife is such

that unless the machine is held it will pull forward toward the tunnel heading.

The section of the Mount Elliott Ave. sewer bored by the machine is about 5000 ft. long. The cut made by the machine is an 11-ft. 2-in. circle and the finished section inside the brick lining has a 9-ft. clear diameter. This tunnel was dug from three shafts; in the first one the heading for a short distance in one direction was driven by

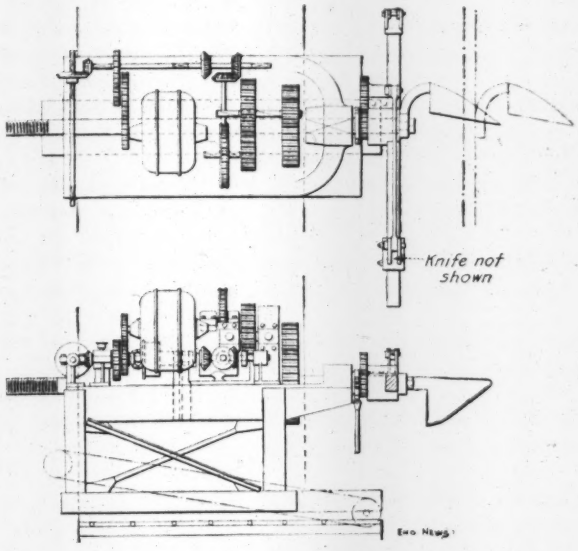


FIG. 2. GENERAL DETAILS OF THE BONNETT TUNNELING MACHINE

ordinary mining methods and in the other by the machine. The formation here was of a stiff blue clay, which stood up very easily and cut very readily. The following figures show the comparative costs of driving the tunnel by the machine and by ordinary mining methods, the conditions, except for the method of driving, being precisely similar.

In the hand method, the labor charge was as follows: 6 miners at $5.50 ea., 3 muckers at $2.75 ea., 1 to 4 car pushers at $2.75 ea. This force averaged 8 ft. per day of 8 hr.

With the machine there were two operators, one on the machine at $4 per day and one on the knife at $3 per day; two muckers in front at $2.75 per day; two handy men at $2.75 per day. This force averaged 12 ft. per day of 8 hr.

Behind both of these forces bricklayers were laying the brick lining. These men had to be paid $10 per shift, no matter how long the shift was. With the ordinary mining method, the cut made during the shift previous to the bricklaying shift was often not long enough to keep the bricklayers busy, whereas with the machine the cut was always sufficient to keep them throughout their regular 8-hr. period. In addition, the miners made a much greater overrun than did the machine, which cut true to line and did not require any extra backing. With the hand method sometimes the extra brick backing was as much as 500 bricks per shift.

In some places in the tunnel some rather unsatisfactory sand was met with, and in these places the roof of the tunnel had to be timbered. It is stated, however, by the engineers on the work that the machine did very well in this formation. In a number of places quite large boulders were encountered, but these were picked out by the muckers and gotten out of the way without injuring the machine or impeding its progress.

In the Cleveland tunnel work the two machines are to be used in a shield, with a concrete-block lining machine directly behind them. For a while, at least, they will have to be under air, but it is hoped that the ground will be tight enough to allow open-air driving to proceed.

Figs. 3-4 show the comparative appearance of the machine and hand work in the Mt. Elliott Ave. sewer.

FIG. 3. CUT MADE BY TUNNELING MACHINE

FIG. 4. CUT MADE BY ORDINARY MINING METHODS

FIGS. 3-4. IN THE MT. ELLIOTT AVE. SEWER, DETROIT, MICH.

Economics of Sewage Filters*

By George W. Fuller†

Performance of Filters—The output of a filter of any type, measured at any suitable purification unit, is largely a question of local conditions. It depends upon the nature of the sewage, the nature and fineness or coarseness of the filtering material, the method of application of the sewage to the filtering material, temperature, atmospheric conditions, and many other factors.

Not considering special conditions and just taking fair figures, we may safely state the following:

Intermittent sand filters, 3-ft. bed of sand, loading 1000 population per acre; contact filters, 4-ft. depth of stone, loading 5000 population per acre; sprinkling filters, 7-ft. depth of stone, loading 19,000 population per acre.

The rates, then, for these three types of filters are in the ratio 1, 5 and 19 ft.

Cost of Sewage Filters—Costs of construction are so much affected by local conditions, such as the amount of excavation necessary, the cost of various classes of materials, the distance from which various classes of materials must be obtained, details of local construction conditions, such as competition, class of work required, and others, that comparative costs for different localities are only to be used with great discretion, and individual cost and even averages are only a guide to comparative costs in various places. Having this limitation in mind, we will examine in a rough way the cost of various types of sewage filters on the per capita basis.

The average cost of nine Massachusetts intermittent sand filters is $3260 per acre, as reported in the Massachusetts State Board of Health Report of 1903. This gives a cost per capita connected to the filters of $3.50.

The 1906 Baltimore Sewerage Commission estimates that the cost per acre of filters at $6350, these filters being suitable for a connected population of 1200 per acre. This corresponds to a per capita cost of $5.30.

The cost of contact filters, varying, of course, with the degree of the fineness of the design, may be taken, for filters equipped with suitable convenient appurtenances, at $30,000 per acre for a 4-ft. deep bed. This corresponds with a loading of 5000 population per acre to a per capita cost of $6.

For sprinkling filters 7 ft. deep the cost will be about $45,000 per acre. On the basis of a loading of 19,000 population per acre, the cost per capita will be $2.37.

When considering the relatively low cost of the Massachusetts sand filters compared with the estimate made from the Baltimore sand filters, it is to be borne in mind that the conditions in Massachusetts for the construction of sand filters were unusually favorable and do not represent average conditions through the country. In most places the costs would approximate more nearly those estimated for Baltimore.

Taken in a broad way, sprinkling filters are a far more economical installation in the matter of first cost. Intermittent sand filters and contact filters do not stand far apart in this particular.

Relative Cost of Different Depths—There is not very much known about the relative advantages of filters of shallow or deep construction. The choice of depth is usually made for entirely different reasons from those of obtaining the most economical construction to obtain the desired amount of purification. Very few tests of a comparative kind have been made to give convincing information, and the interpretation of the tests has not been uniform. In some places the conclusion has been made to make filters, say 10 ft., at other places 6 ft., and some study is worth while to determine what if any difference there be in the cost of such construction at different depths, and which would appear to be the better. It is to be assumed in such comparisons that sufficient head would be available in any case for the greatest depth to be considered and that pumping would not be necessitated by building filters of the greater depth.

For intermittent sand filters questions of depth do not arise. The filters are generally made as shallow as is consistent with getting proper results and sand beds are not usually made more than 4 or 5 ft. deep as a maximum. Shallower beds, even, will give about the same output as the deeper beds, and beds are made deep only so that sand may be removed for cleaning without removing the sand for a considerable period.

With contact filters it is recognized that from the nature of the action of the contact filters, where the amount of air that is drawn in between fillings of sewage is practically equal to the volume of the sewage, and where surface clogging cannot be a serious factor and may even be no factor at all, each unit of volume of the stone forming the filter, say each cubic yard, will give the same output of sewage purification, no matter what may be the depth of the filter.

From this it follows that it is economical to build a sewage filter on the contact principle as deep as local conditions of construction will permit, and the limitation of depth which it is economical to use is therefore made by the factors of earth excavation or fill and the possible head available without pumping.

When it comes to sprinkling filters, the problem becomes a little more complicated. The English experience, as recited in the Report to the Royal Commission, seems to indicate that the output per unit of volume of sprinkling filters is the same, no matter what the depth. Our experience in work in this country does not wholly corroborate this information. Our best knowledge seems to indicate that the output per unit of volume of sprinkling filters is somewhat less for deep filters than for shallow filters. For such conditions, with a relatively decreasing efficiency of the stone of the filter beds for greater depths and at the same time a relatively decreasing cost per unit volume of the stone for deep beds, there must come some point where the greatest output per unit of cost will be obtained.

The Report of the Baltimore Sewerage Commission in 1911, gives some information obtained from tests made in Baltimore as to the relative efficiency of various depths of broken stone of sizes 1- to 2-in. stone, which is the one most commonly used. Figures obtained from that source show the following:

	6 ft.	9 ft.	12 ft.
Relative stability	79	87	89
Per cent. reduction of oxygen consumed	56	70	72

Giving equal weight to the relative stability and per cent. reduction of oxygen consumed, we get the following:

	6 ft.	9 ft.	12 ft.
Relative stability	1	1.2	1.23
Per cent. reduction of oxygen consumed	1	1.25	1.28
Average of the two	1	1.22	1.25
Relative depths	1	1.33	2.00
Relative value of stone per cubic yard	1	.92	.63

*From a paper read before the American Society of Municipal Improvements, Boston, Mass., October, 1914.

†Consulting Engineer, 170 Broadway, New York City.

Assuming this depth varies at a uniform rate from one end of the curve to the other, we get the following for the relative value of stone per cubic yard:

Depth of bed	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.	12 ft.
Relative value of stone per cu.yd.	1.0	0.97	0.94	0.92	0.82	0.63

To get comparative figures, then, between the 6-, 8- and 10-ft. beds, the cost figures for the 8-ft. beds must be divided by 0.94, and the cost for the 10-ft. beds by 0.82, putting them all on the basis of the 6-ft. beds.

For comparative cost a number of factors, such as excavation, etc., are naturally omitted, as they are not affected in all places the same way by the depth of the filter. Comparing, then, only those particular costs which are affected per unit of output by the depth of the filter, we get the following costs per effective cubic yard for depths of 6, 7 and 8 ft.:

	Depths, ft. 6	7	8
Floor	$0.40	$0.35	$0.32
Tile	.49	.44	.40
Walls	.17	.17	.18
Galleries and Collectors	.25	.22	.20
Distribution	.50	.50	.50
Stone	1.50	1.55	1.60
Total	$3.31	$3.23	$3.20

Outside factors will depend on quantity only and not on depth.

It appears, then, that there is some slight saving of cost, which, on the figures given in the table, amount to about 3%, in favor of the 8-ft. deep bed, as compared with the 6-ft. deep bed. On the other hand, it is to be recognized that a deep bed will give a good deal more trouble with pooling and freezing than a shallow bed, and the advantages in favor of a shallow bed due to this lesser amount of pooling will be considerably more than this 3% difference in cost. Taking everything into account, the writer believes that a sprinkling filter of bed of not less than 6 ft. and not more than 7 ft. will, in the greater number of cases, prove the most economical to use.

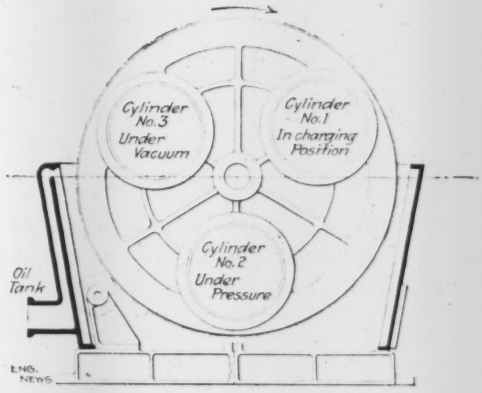
A New Type of Creosoting Plant

A creosoting plant of novel type now being tried in Scotland has as its special features an entirely new design of the treating plant, a very short period of impregnation, and a very high pressure for this impregnation. The retort consists of three horizontal cylinders 33 in. diameter and 28½ ft. long, mounted between two end plates or disks which have openings to receive the cylinders and are carried by a central longitudinal shaft. The entire machine is immersed in an oil tank which is kept filled to the level of the shaft. The general arrangement is shown in the accompanying cut. The end plates are driven intermittently by gearing in such a way that every four minutes the retort revolves through an angle of 120°. The movement occupies 18 sec., the retort being then at rest for 3 min. 42 sec.

In the first position, with two of the cylinders above the level of the tank, the cylinder at the right is in line with the feed trough (above the end of the tank) and a charge of 24 ties is pushed in by a ram. The frame then revolves (clockwise) 120°, immersing the cylinder in the tank. After 60 sec. (to allow the fluid to completely fill the cylinder), sealing pistons move out and close the ends of the cylinder in 12 sec. A pressure of 400 to 500 lb. in the cylinder is then raised by pumps in 12 sec. and maintained for 2 min. 6 sec., followed by a release in 12 sec., completing the 4-min. period.

The frame then revolves 120° bringing the cylinder out of the tank (and immersing the second cylinder). Other sealing pistons again close the ends while a vacuum is created to withdraw a proportion of the creosote. The frame then revolves through 120°, completing its revolution, when the charging ram pushes in a new charge of ties, thus pushing out the treated ties at the other end. The operations are the same with each of the three cylinders, so that at each 4-min. interval a charge of 24 treated ties is ejected.

The partial recovery of oil from the wood is one of the



Sectional Elevation of Revolving Triple Retort for Creosoting Ties

features of the system (which is termed the "save-oil" system), and a series of tests of this process and the full-cell process showed results as follows:

	Save-oil process	Full-cell process
Average increase in weight per tie.	21.22%	30.05%
Average creosote per cu.ft.	7.04 lb.	9.97 lb.
Average creosote per tie.	2.18 gal.	3.09 gal.

The plant can be adapted, however, for the full-cell creosoting process or for the zinc-chloride process, the vacuum treatment being then omitted. The operation is continuous and rapid, and gives an output of 360 ties per hour. The plant is compact and occupies comparatively little space, but has considerably more machinery than a plant of the ordinary type. It works also on the principle of high pressure maintained for a short period, the actual pressure period being but a few minutes instead of several hours. However, the amount of oil forced into the wood is said to be greater than by the ordinary process. Ties, poles, bridge timbers and paving blocks can be treated in the same way.

The new process and plant are owned by the Saveoil Creosoting Co., Dickson, St., Glasgow, Scotland, Experiments were made first at the Royal Technical College, Glasgow, and as a result of these a complete plant has been erected at the creosoting works of the Glasgow & Southwestern Ry. Our information is taken from an article in *The Engineer,* of London.

The Pavements of Guayaquil, Ecuador, consist of large blocks of stone averaging 12x12 in. on top. They are laid directly on the soil. About 15 miles of a total of 45 miles of streets are so paved.

The Volumetric Measurement of Liquids on a Large Scale

By Geo. Jacob Davis, Jr.*

It is the purpose of this article to point out some of the causes of error in the volumetric measurement of liquids on large scale and the magnitudes of the errors, together with a method of gaging measuring basins to avoid errors, in so far as possible.

Gaging the Measuring Basin—In many cases it is desirable to measure liquids in calibrated tanks or basins. A tank for this purpose is usually provided with a glass gage or other device for showing the depth of contained liquid, and on the gage scale is marked the weight or volume of liquid contained in the tank at various heights. In gaging the tank or basin a definite amount of the liquid is weighed into the tank and a mark is made on the gage scale, and the operation is repeated until the tank is full.

Before beginning the calibration the weighing scales should be tested under various loads by standardized weights. Scales are subject to a number of errors which may be summarized as: (1) erroneous graduation of the scale arm; (2) poise of wrong weight; (3) weights inaccurate; (4) shifting of knife edges in the link bearings. On account of the last mentioned errors the scales should be placed in their final position before calibrating and should thereafter be protected from jars or vibrations which might shift the positions of the knife edges. A variation of over 0.2% has been found in scales before and after moving them from one part of a room to another. (The accompanying data sheet shows a convenient form for tabulation of data.)

If the tank has practically vertical plane walls, the average cross-sectional area may be determined, from which, with the initial and final gage heights, the contents may be computed. Usually, however, there are projecting gates, etc., and irregularities in the side walls which make this method impracticable. In six gagings of a 1000-cu.ft. tank by a number of senior students, the computed average horizontal cross-section ranged from 164.8 sq.ft. to 168.2 sq.ft., a variation of over 2%. With the following method, devised by the writer, the maximum variation from the mean capacity of the tank, as determined by half a dozen calibrations by different parties of students, is not more than $^1/_{20}$ of 1%.

The volume of each tankful of water weighed into the basin was calculated by dividing the observed weight by the density of pure water at the observed temperature, careful observations having shown that the density of the lake water was the same as that of pure water, out to the fifth decimal place. The volume of water in the basin at various depths could not be conveniently plotted, against gage heights, to a sufficiently large scale to show the discrepancies in the various calibrations, so the following method was adopted. Since the smallest horizontal area of the basin was a little above 160 sq.ft., the volume of contained water above the zero of the tank gage is given by

$$V = 160\ G + X$$

in which G is the tank-gage reading and X may be called the excess. It was not possible to read lower than about 0.3 ft. on the gage scale, owing to its being placed too low, so the absolute quantity of water in the basin above the zero of the gage could not be determined by the above formula, but the excess volume, x, between any two gage heights, g_1 and g_2 is given by the formula

$$v = 160\ (g_2 - g_1) + x$$

in which v is the actual volume of the tank between gage heights g_1 and g_2. In gaging the basin the elementary excesses, for each tankful of about 1800 lb. of water were calculated, and these were summed as shown (accompanying data sheet) in the column headed cumulative excess, which shows the total excess between any observed gage height and the initial gage height of that particular gaging.

In order to compare the results of different gagings of the basin, it was necessary to determine what the excess would have been had all the initial gage readings been the same. This was done by dividing the data of each gaging into two groups of observations and determining the average gage reading and the average value

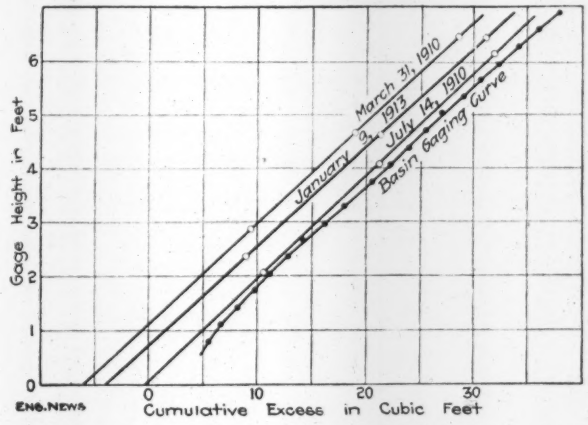
*Dean, College of Engineering, University of Alabama, Tuscaloosa.

TABULATION FOR LARGE-SCALE VOLUMETRIC MEASUREMENT

Experiment on calibration of basin No. 4. Computed by Davis.
Data by Davis, G. J., Jr.
Date of experiment, Aug. 2, 1911.
General Data: Scales No. 764.560. Error = +3¾. Intercept = 4.00 cu.ft. Density of water = 0.99747 × 62.4 = 62.25.

No. of Run	Temperature Water	Temperature Gage	Gage reading	True depth	Weight Gross	Weight Tare	Weight Net	Corrected weight	True vol.	160(h₂-h₁)	Excess	Cumulative excess	Corrected cumulative excess
1.....	23.8	24.1	0.517	Same as gage readings.	1833	310¾	1522¼	1518½	24.39	24.00	0.39	0.39	4.39
2.....	23.9	24.0	0.667		1839½	312¼	1527¼	1523½	24.47	23.84	0.63	1.02	5.02
3.....		23.8	0.816		1843½	311	1532½	1528¾	24.56	24.16	0.40	1.42	5.42
4.....			0.967		1832	307¼	1524¾	1521	24.43	24.16	0.27	1.69	5.69
5.....		23.5	1.118		1833½	217¼	1616¼	1612½	25.90	24.80	1.10	2.79	6.79
6.....			1.273		1831½	312¼	1519¼	1515½	24.34	24.00	0.34	3.13	7.13
7.....	23.8	23.5	1.423		1834	309	1525	1521¼	24.44	23.84	0.60	3.73	7.73
8.....			1.572		1841¾	312½	1529¼	1525½	24.51	24.00	0.51	4.24	8.24
9.....		23.8	1.722		1829½	310½	1519	1515¼	24.34	23.36	0.98	5.22	9.22
10.....	23.8		1.868		1832½	309¼	1523¼	1519½	24.41	24.32	0.09	5.31	9.31
11.....			2.020		1831¼	310	1521¼	1517½	24.38	23.20	1.18	6.49	10.49
12.....			2.165		1830¾	308¾	1522	1518¼	24.39	23.36	1.03	7.52	11.52
13.....			2.311		1832¼	306½	1525¾	1523	24.47	23.84	0.63	8.15	12.15
14.....			2.460		1839	307¼	1531¾	1528	24.55	24.00	0.55	8.70	12.70
15.....			2.610		1830½	304¾	1525¾	1522	24.45	23.68	0.77	9.47	13.47
			2.758										

of the elementary excesses for each group and also for the entire gaging. These values when plotted on cross-section paper will lie on a straight line if the calculation is correctly done. The average lines for three gagings have been plotted in the accompanying figure. The intercepts of these lines on the X axis were added to the values of the cumulative excess and the resulting values were plotted as abscissas against gage heights as ordinates. The corrected cumulative excess for the January, 1913, gaging only has been plotted to avoid confusion. An irregular line has been drawn through the points, which shows the variation in the horizontal cross-section of the tank due to projections and other irregularities in the walls. The results of any number of gagings may thus be put on a comparative basis. If the plotted values deviate much from a straight line this method will



COMPARISON OF BASIN GAGINGS AT UNIVERSITY OF ALABAMA

not give satisfactory results unless the gagings cover practically the same range of elevations in the basin.

To compute the quantity of water V in the basin between gage heights G_1 and G_2 the following formula is used:

$$V = 160\ (G_2 - G_1) + (X_2 - X_1)$$

In this formula X_1 and X_2 are the corrected cumulative excess for gage heights G_1 and G_2, respectively, and are taken from a curve similar to that shown but plotted to a large scale. The constant 160 applies to the particular tank used in the above experiments only.

TEMPERATURE ERRORS—In case the liquid to be measured is at a different temperature from that used in gaging the tank an error will be introduced on account of the variation of the specific volume of the liquid at different temperatures. For example, suppose a measuring tank is graduated at 60° F. to show the weight of water, in 100-lb. units, contained in it when filled to certain elevations, and water at 100° F. is afterwards measured in it. The volume of 100 lb. of water at 60° is 1.6034 cu.ft. and the weight of 1.6034 cu.ft. of water at 100° is 99.383 lb. Therefore an error of 0.617% would be introduced into the measurements, assuming the volume of the tank to remain constant. If the tank is made of thin steel which would have practically the same temperature as the contained water, the tank, as well as the water would expand with the increase in temperature, but not at the same rate. Assuming a coefficient of linear expansion of steel of 0.0000065, the new volume at 100° of the portion of the tank formerly occupied by 100 lb. of 60° water would be 1.60425 cu.ft., which would contain 99.460 lb. of 100° water, giving an error of 0.54%. On account of the shape of the expansion curve of water the error will rapidly increase with the temperature. For example, if the tank is gaged at 75° and water at 180° is measured in it, an error of 2¾% will be introduced into the readings.

In the case of a large concrete measuring basin where the gage was located some distance away in an engine room the temperature of the gage and its contained water was at times quite different from that in the basin. In the winter when the water in the tank was at a temperature of 4° C., the gage temperature was found to be 20° C. When the gage indicated a depth of 8.000 ft. at 20°, it was balanced by a depth of 7.986 ft. of heavier water at 4°. The gage readings were, therefore, in error 0.175%. This error is small as compared with those permissible in commercial work, but such constant errors should not be allowed in experimental work. The data shown in the tabulation sheet were taken in the summer when the temperature of the water in the gage and in the basin were the same and hence in this case there was no correction to apply to the gage heights. In the diagram, however, it may be seen that the average line for the January gaging has a flatter slope than those taken in the summer, which is fully accounted for by the fact that the correction for gage temperature was not applied.

ABSORPTION—There is a possibility of the masonry wall of measuring basins absorbing an appreciable amount of water if they are dry at the time of filling. The effect of such absorption was investigated by Fteley and Stearns* in their experiments on weirs. It was found that the dry brick of the walls absorbed 12% of their volume, while brick taken out of the water and left standing on end in a damp place when again immersed absorbed 1½%. If the cross-section of the measuring basin is small in comparison with the thickness of the walls the percentage of error due to neglecting the absorption may be relatively large.

LEAKAGE—In the operation of sluice gates various amounts of leakage are likely to occur, due to chips preventing the gates shutting tightly. In the attempt to shut the gate sufficient force is sometimes applied to buckle he gates slightly, thereby causing an increase in the leakage. After shutting the gate tightly the hand wheel should be reversed so as to relieve the gate and stem of all strain. The gates should be so placed that it will be easy to inspect them during each experiment, to detect leakage.

Large leaks through the walls may be stopped by calking, or pointing up the cracks, and small leaks can be reduced by putting bran and other sediment in the water, or by the use of a waterproof paint. The rate of leakage should be determined by filling the tank to various heights and noting the drop in the water surface in, say, ten hours, making due allowance for evaporation.

YIELDING OF WALLS—Rectangular basins of wood or metal are likely to become distorted due to the weight of the liquid. The practice of computing the capacity of such basins from contours of the side walls when empty would therefore be inaccurate. The method outlined above would give correct results.

*Trans., Am. Soc. C. E., Vol. 12, p. 71 (1883).

Field and Office

Novel Stop for Gantry Cranes

The recent wrecking by a high wind of a large gantry crane used for handling coal in storage, directs attention to the extent to which such structures are menaced by violent storms. Included in the coal-handling equipment at the Astoria, L. I., plant of the Consolidated Gas Co., of New York, is the largest such gantry crane ever built. It is 603 ft. long, with a span of 250 ft. c. to c. of tracks. It weighs 550 tons and runs on a track about 1000 ft. long. A wind of sufficiently high and sustained velocity

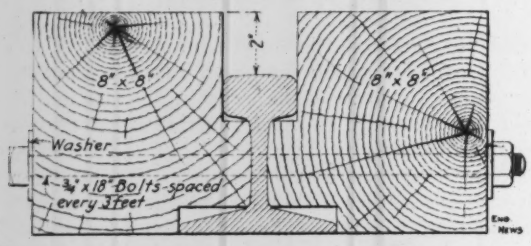


FIG. 1. ARRANGEMENT OF STOP LOGS ALONG RAILS

to move a 550-ton gantry crane is not a frequent occurrence; but only one such gale is required to send several hundred thousand dollars to the scrap heap.

At the time this structure was built the engineers of the gas company recognized the seriousness of this matter and undertook to provide safety devices for preventing the gantry being driven off the tracks by the wind. The last 50 ft. of the rails at each end of the track were inclined upward 1 ft., and 8x8-in. wood stringers were bolted to each side of the rails of the last 25 ft., as shown in the sketch, Fig. 1. The top of the rail head is 2 in. below the upper face of the stringers, or stop logs as they are called.

A computation made as to the value of this device assumed as an extreme condition that the gantry was caught in the prolonged gust of a gale and given a velocity of 15 ft. per sec.

Should a runaway occur, when the forward trucks of the gantry ride up on the inclined rails, gravity would tend to bring the crane to a stop. The main resistance to movement is introduced when the double-flanged wheels mount the stop logs. The flanges would, of course, crush into the timbers, developing a high tractive resistance.

The Astoria gantry crane was built by the Brown Hoisting Machinery Co., Cleveland, Ohio, in 1908. The tracks, including the safety device, were designed and constructed by the Engineering Department of the Consolidated Gas Co.

⁂

Lining a Railway Tunnel with Concrete by Compressed Air

A recent application of the method of delivering concrete in place by means of compressed air is the lining of the Alkali Summit tunnel on the new line of the Chicago, Burlington & Quincy R.R., between Thermopolis and Orrin Junction, Wyo. The tunnel is 800 ft. long, in sandstone which required timbering throughout. It was completed in 1913, and is now being lined with concrete. The tunnel has vertical sides and arch roof.

The timbering is removed in advance, as it does not leave sufficient roof for the new lining. It is pulled down by fastening to the feet of the posts a cable which is led through a snatch-block at the middle of the track and attached to a dinky locomotive. Any loose rock in the roof is removed. To protect the men erecting the forms, roofing planks are laid from the completed concrete to the next set of timbering. These planks would catch small pieces of rock, while larger rocks would be impeded and would give sufficient warning to enable the men to get out of the way. The length of timbering removed at one time varies from 5 to 20 ft., according to the apparent safety of the rock roof.

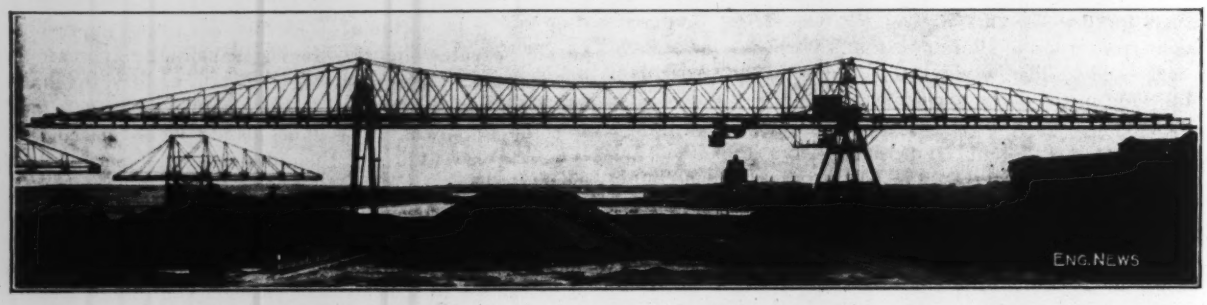
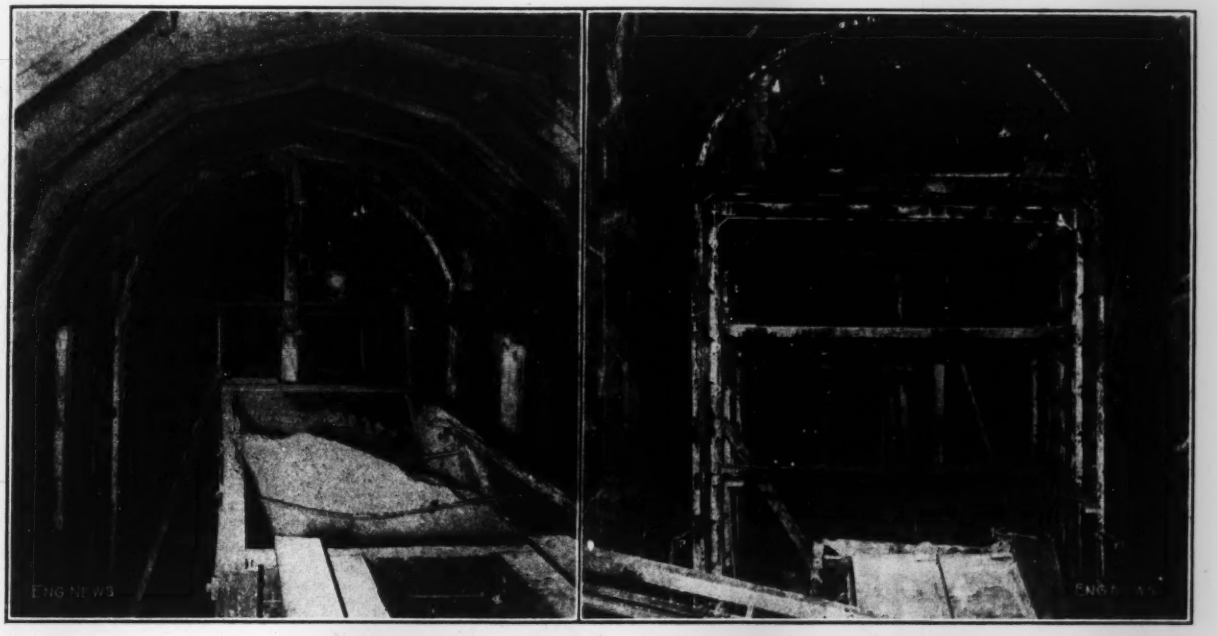


FIG. 2. THE 603-FT., 550-TON, COAL-HANDLING GANTRY CRANE AT ASTORIA, L. I.
(Last 50 ft. of track at both ends inclined 1 ft., and 8x8-in. stop logs bolted to each side of rails of last 25 ft. See Fig. 1.)

The forms are of steel, consisting of channel ribs (shaped to the tunnel section) placed 4 ft. apart and carrying a lagging of steel plates 4 ft. long and 3 ft. high. This lagging is built up to the top of the arch, as forcing the concrete into place by compressed air permits the forms to be built complete before concreting begins. From one to five lengths of the form are set up at a time, depending upon the character of the rock.

The mixing and placing outfit consists of a pneumatic concrete mixer and conveyor mounted upon a 40-ft. flat car, equipped with bins holding 26 cu.yd. of material. The cement is stored in bags under one of the bins, and discharged toward the center of the car through chutes into a measuring hopper, which is tilted automatically by a 6-in. air cylinder to discharge into the mixer. The 8-in. delivery pipe leads from the mixer under the car and vertically up at the end to the crown of the arch, where a 90° elbow enters through the bulkhead of the form and forms the delivery nozzle. The top section of the pipe, with the elbow or nozzle, is slung from the roof by tackle, and has a screw-joint connection with the vertical pipe at the end of the car. It can be swiveled horizontally so as to direct the stream of concrete to all parts of the form. Air is supplied from a compressor at the mouth of the tunnel by a 4-in. main, with hose connections to the receiver on the car.*



PLACING CONCRETE LINING BY COMPRESSED AIR IN THE ALKALI SUMMIT TUNNEL; CHICAGO, BURLINGTON & QUINCY R.R.

(The view at the left shows the head of the concreting car, with its material bins and vertical concreting pipe. The top section of this pipe, with elbow entering the end bulkhead of the form, is suspended from the roof by tackle, and has a swivel joint with the pipe on the car. The timbering is removed as the concrete lining advances. The view at the right shows the concrete lining and the steel forms, the latter consisting of ribs and panel plates.)

This portable concreting plant requires for proper working a compressor with a capacity of about 300 cu.ft. free air per minute, at 80 to 100 lb. pressure. In beginning the work, however, the only compressor available was one in poor condition and furnishing only about 80 cu.ft. per minute. It was driven by a gasoline engine.

The sand and gravel, dredged near Casper, is hauled in gondola cars and delivered along the track near the tunnel. Cement is stored in a small shed. The bins on the car are loaded by a portable derrick with a wooden skip which is filled by shoveling, as a clam-shell bucket was not available. The car was taken into the tunnel by means of the dinky engine and spotted at a point next to the forms, and its delivery pipe connected to the upper section was suspended in place. The air connection was then made and concreting immediately commenced.

For the first 20 ft. of the lining the work was as follows: Tearing down the timbers, 128 man-hours; erecting forms, 229½ man-hours; loading gravel and cement onto the car, 140 man-hours; mixing and placing concrete in the forms, 204 man-hours. The total yardage placed was 132 cu.yd. The number of man-hours required per yard of concrete was 0.97 for tearing down and clearing timbers, 1.74 for erecting forms, 1.5 for mixing and placing concrete and 1.06 for loading gravel and cement. The delays were 3½ hours on account of blowing off an 8-in. nipple, and 2 hours on account of a derailment of the derrick car.

The substitution of a clam-shell bucket is expected to cut the cost of loading the car to about 0.3 man-hour (or, say 10c. labor cost) per cu.yd. The substitution of a 300-ft. compressor will make it possible to mix and place one batch per minute. The number of batches made with one loading of the car varies between 112 and 118. The time required for placing this amount of concrete, including time of transporting and for connecting and disconnecting the delivery pipe, is about 210 to 240 min.

This portable outfit was designed by the Concrete Mixing & Placing Co., of Chicago, Ill., which also furnished the pneumatic mixer and conveyor apparatus.

*This concreting car was described and illustrated in "Engineering News," March 26, 1914. At that time, however, the delivery pipe was inclined, while the vertical pipe has been found much more satisfactory.

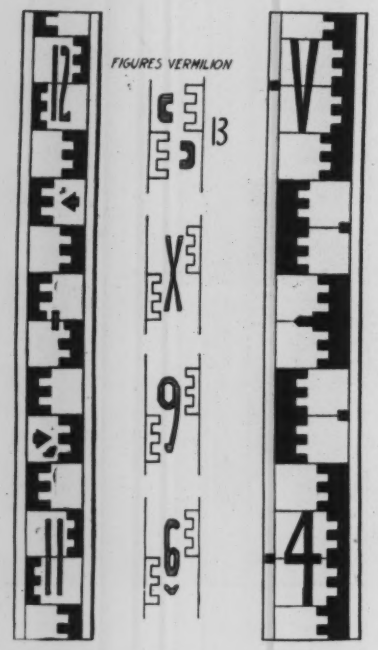
Fish in Chicago Water Mains—During the past year 153 fish traps were installed where complaints were continually received of meters filling up with fish. These traps were so constructed that consumers could clean them without calling on the Water Department.

Rod for both Stadia and Direct Leveling

By W. S. Nichols*

Fig. 1 shows a pattern for a combined stadia and level rod, which has proved by long experience to be of great practical value. It is substantially the design of Harold Van Du Zee, a consulting engineer of Philadelphia, Penn. This rod is especially convenient to the surveyor who has occasion to take close topography and also long-distance readings, and has been enthusiastically approved by those who have used it.

The advantages are: That the alternate tenths being staggered, there is no hesitation in assigning their position; that dividing each 0.1 into 0.02 allows a more striking marking than into 0.01, while there is no difficulty in estimating to 0.005; that after an hour's practice, one can almost instantly and automatically take an accurate reading; that it can be read at considerably greater distances than the usual compromise patterns; and that it may be adapted to a rod of permissible weight.



Combined Stadia and Level Rod

An important principle, and one which is embodied in the U. S. Coast & Geodetic Survey rod, is that the eye can more readily estimate the subdivisions of a rectangle than of a triangle.

A feature deserving attention is that the figures designating the feet should be so characterized that no one of them shall be likely to be confounded for another. Suggestions for such numerals are shown in Fig. 2. Instead of a numeral at the 6-ft. mark, a cross like a plus sign might be more distinctive.

Some years ago, the writer adopted this pattern and further tried having the alternate feet marked white, yellow, white and so on. As was expected, this was not of great value at great distances in certain lights, but often times it has been found convenient, as when a foot mark is obscured by brush or foliage.

The rod shown in Fig. 1 is 2 in. wide. A greater width will allow better marking but will also mean increased weight and more surface to be acted upon by wind.

The author has a rod 2¼ in. wide and 13 ft. long, made of white pine and red birch, which is somewhat lighter than many Philadelphia rods. He has also a Philadelphia rod re-marked with this pattern by painting the black blocks out to the edges, after filing down the flanges slightly, at alternate tenths, so that the paint is not rubbed by the sliding sleeve-guide.

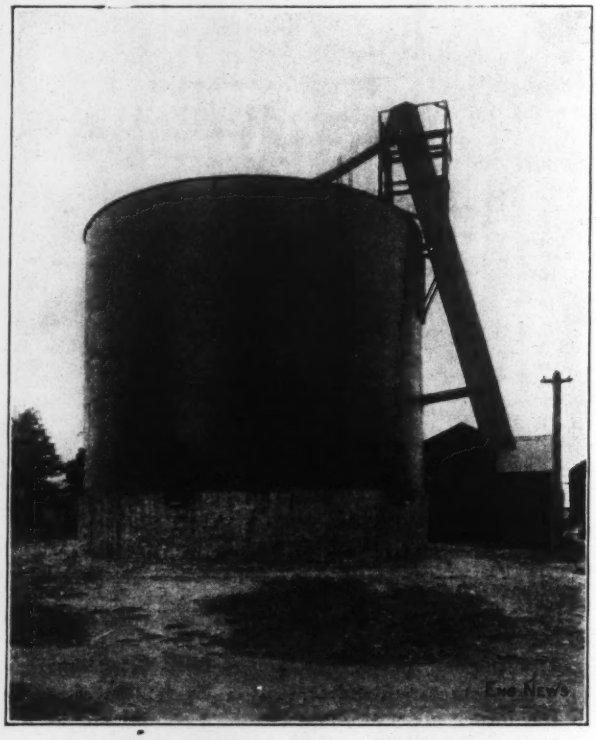
Fig. 3 illustrates another pattern, also a design of Mr. Van Du Zee's, which allows a longer range, though not so easily adaptable to a rod of as light weight as is the first.

*717 Walnut St., Philadelphia, Penn.

Steel Tank for Coal Storage

The proprietor of a retail coal yard in North East, Penn., stores his stock, except the large lump varieties of coal, in a circular steel bin, fashioned somewhat after the manner of a circular grain bin. The dimensions of the bin are, height and diameter, each about 40 ft. It rests on a brick foundation about 6 ft. high.

The coal which is to be unloaded into the bin is allowed to run from hopper-bottom cars into a pit under the center of the track. A bucket conveyor, inclosed in a chute



Steel Tank for Coal Storage; North East, Penn.

and propelled by an electric motor, carries it to the top of the bin, where it may be diverted into any one of six compartments.

When delivery is to be made to a retail customer, the driver backs his truck under the gate of the proper compartment. The coal runs from the bin through a chute, the bottom of which is a screen, so that it is cleaned while being loaded.

This method of handling coal is found to be economical and satisfactory for several reasons. The expense for labor is small and the proprietor is independent of that uncertain class of help upon which in ordinary times he must depend. Orders can be gotten out very rapidly when the first cold snap comes and a great many householders

suddenly remember that they forgot to order coal. No insurance is carried on the bin shown in the accompanying view. The builder is the VonWald Engineering Co., of Buffalo, N. Y.

A High-Speed Valveless Displacement Pump

An unique design of valveless pump, giving large capacities for small sizes and weights is shown in the accompanying figures. The type is adaptable for wide ranges of service and a standardized line is available. It is reported that satisfactory service has been secured (with single-stage units) for hot and cold water, gasoline and volatiles, heavy fuel oils, molasses, soaps, sludges, tar and asphalt; vacuum pumps and compressors have been built in one-, two- and three-stage units. The principle is familiar but has not before been commercialized for miscellaneous small services or in such multistage single-impeller units.

The relative sizes and capacities may thus be shown: For general water-supply, boiler feed, etc., a small unit, 17x12¾x12¾ in. with 1½-in. suction and discharge runs from 50 to 800 r.p.m. and discharges 0.035 gal. per revolution; the maximum designed pressure is 200 lb. per sq. in. and the maximum capacity 25 gal. per min. The largest unit for this service is 26x20x22 in., runs at from 50 to 700 r.p.m., and has a maximum capacity of 300 gal. per min.

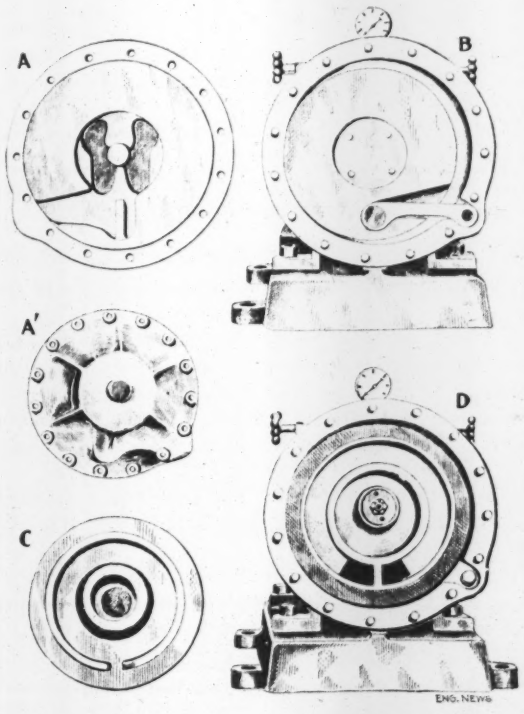


FIG. 1. THE MAY-NELSON PUMP TAKEN APART
(A, A', cover removed; B, impeller and back link in place; C, D, impeller removed.)

The same pump may be used for vacuum service working at 24 in. wet or dry, and giving an air displacement of 0.0047 cu.ft. per revolution or 40 cu.ft. per min. at maximum capacity. A special design (three-stage) of high-vacuum pump supplements the general line noted, holding a vacuum of 0.05 mm. pressure; the same pump may be used to furnish both suction and blast if desired. Another special pump, 4x4¾ in. and weighing 4 lb., has a blast displacement of 0.7 cu.in. per revolution and gives a vacuum of 29¾ in. at 800 r.p.m.

The design, shown in the accompanying figures, comprises a flat cup-shaped casing finished with two or more concentric annular ridges cross-connected by a stop partition with inlet and discharge ports on either side. Into the casing grooves thus formed fit rings cast on an impeller plate properly cut to straddle the casing-groove bridges. This impeller is mounted eccentric with the casing and rocks but does not revolve, being restrained by a back link to the casing. The shaft carries the impeller on an eccentric end pin working in either plain or roller bearings.

The net result is that the rings on the impeller plate roll and slide on the adjacent rings of the casing, as shown in Fig. 2. In *A* the pump is discharging through the right-hand port and drawing through the left; the exterior space is filled. In *B* (90° later) the inner space is completing both discharge and fill while the outer space is beginning both. In *C* (another 90°) the interior space is filled and the exterior one is ready to discharge. In *D* (270°) the inner space is discharging well and beginning suction; the outer space is filling well and completing discharge.

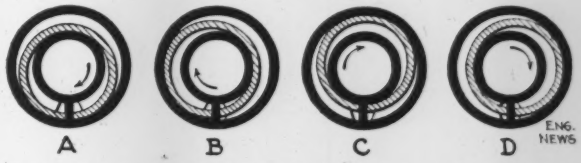


FIG. 2. DIAGRAM SHOWING OPERATION OF MAY-NELSON DISPLACEMENT PUMP

In those designs employing multiples of the simplest arrangement shown, the ports may be connected for multiple or series effect, or they may be used independently as for vacuum and blast simultaneously.

In pumping it is necessary to balance the impeller plate to prevent leakage and friction; as the back of the plate has more effective surface than the grooves, about one-third the operating pressure is admitted to the rear chamber, *A* and *B*, Fig. 1. This is done by adjusting opening of valves in balancing lines run from rear chamber to suction and discharge lines.

High volumetric and mechanical efficiency is claimed though figures are not published. The most of the pumps now in use are in laboratory service but definite operating data seem not to have been secured.

This pump is designed and built by the May-Nelson Manufacturing Co., Washington, D. C.

Traction Engines Are Causing Serious Damage to Maryland Roads, according to a recent newspaper report. The State Roads Commission cannot get local authorities to enforce the law regarding the use of traction engines with cleated wheels; because the farming communities are just now threshing their grain. An injunction to prevent the use of traction engines on state roads without covering the wheel cleats has been refused in Frederick County. The Roads Commission now proposes to equip a traction engine with filler blocks for the wheels, and exhibit it at the county fairs as an object lesson of how damage to the roads may be prevented.

Traveling Cranes for Bridge Wrecking and Erection

In the reconstruction of the Southwark Bridge over the Thames, at London, overhead traveling cranes were used for the removal of the old cast-iron arch ribs and the erection of the new steel arch ribs.

The old bridge (built in 1819) had a center span of 240 ft. and two side spans of 210 ft., each composed of six ribs, and each rib composed of 13 segments or panels weighing 6 to 8 tons each. The ribs were 8 ft. deep at the springing and 6 ft. at the haunches, and were connected by cross frames and diagonal bracing. In the original erection of the ribs, the crown segments were placed first and then the adjacent segments on each side, the segments at the springing being placed last. The bridge was 42 ft. 6 in. wide, with a 29-ft. roadway, and the approach grades were severe. The new bridge will have five arch spans: 140 ft. 6 in. for the center, 131 ft. 9 in. for the intermediate, and 126 ft. 9 in. for the shore spans. It will be 55 ft. wide, with a 35-ft. roadway.

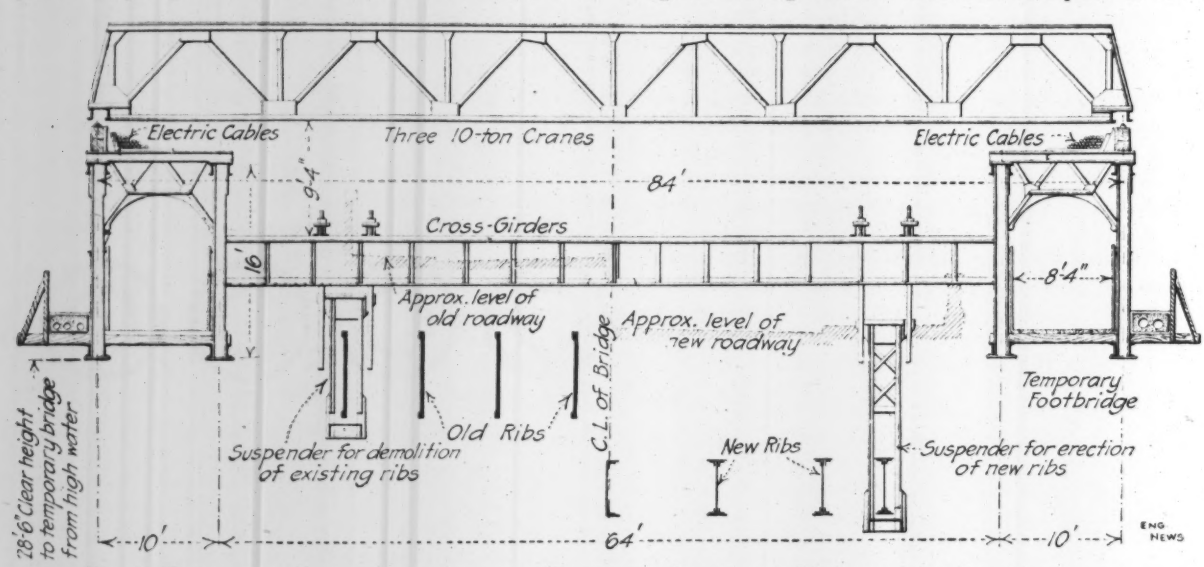


FIG. 1. TEMPORARY FOOTBRIDGES CARRYING TRAVELING CRANES FOR WRECKING AND REBUILDING THE SOUTHWARK BRIDGE OVER THE THAMES, AT LONDON

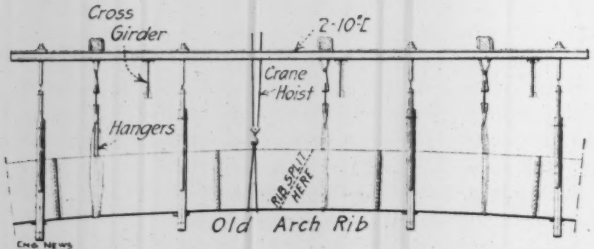


FIG. 2. METHOD OF SUPPORTING THE OLD ARCH RIBS FROM OVERHEAD FALSEWORK DURING THEIR REMOVAL

Along each side of the bridge was erected a through-truss footbridge, consisting of five-span continuous lattice trusses on pile piers. These were built on the old bridge and pushed out laterally upon the temporary piers. A deck on the top chords carried the various electric cables, and an extension of the wood floor beams carried water and gas mains. Over the top chord of each outer truss was built a runway beam of two 12x12-in. timbers surmounted by a 70-lb. rail. The two rails were 84 ft. c. to c., and on these ran the grooved wheels of three 10-ton traveling cranes, the girders of which were parallel-chord trusses 7 ft. 9 in. deep.

Posts in the inner truss of each footbridge supported transverse girders, to which were attached hangers holding the arch ribs during the removal of the segments. These girders were 19 ft. 6 in. apart, and connected by diagonal bracing. Across them were laid pairs of 10-in. channels, with washer plates on top for the nuts of the threaded stems of the hangers for the ribs.

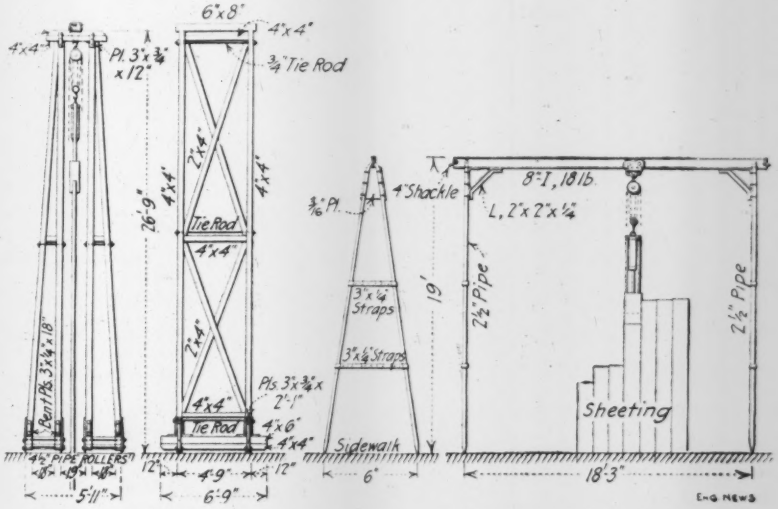
Fig. 1 is a cross-section showing the temporary footbridges, the erecting cranes and the position of the old and new arch ribs. Fig. 2 shows the method of supporting the ribs by hangers and strings. The dotted line on the crown segment (Fig. 2) shows the row of holes drilled to split this segment in two. The other segments were then removed by breaking out the joints. The consulting engineers are Mott & Hay. Sir Wm. Arrol & Co. have the contract for removing the old and building the new bridge. Our information is condensed from an article in *The Engineer*, of London, from which also our illustrations are reproduced.

A New Exterior Finish for Surveying Instruments is being used by C. L. Berger & Sons, Boston, Mass., who for some time past have used a cloth finish on the metal parts of instruments. The new finish is an imitation morocco leather having a close-grained surface, which is soft and pliable, and is claimed to be much superior to the old-style cloth finish. It is said that instruments finished in this manner heat up and cool down very gradually, causing a minimum derangement of the adjustments. The dark color of the finish is claimed to be a particular advantage. The new finish is further claimed to be impervious to dampness and dryness, and to mine or salt water, and that it will not fade or crack. Dust, dirt and grease may be readily washed off. It has been found difficult to determine the wearing qualities of leather and cloth finishes of surveying instruments under the various conditions of cold and of the tropics. This new leather finish, the makers state, has been used to a limited extent for several years, but is now being generally applied to Berger instruments.

Gantry Frames for Sheetpile Drives

On a section of the new Seventh Ave. subway in New York City the U. S. Realty & Improvement Co. is using a simple gantry frame to support the hammer for driving the sheetpiling along the side of the main trench. The gantry originally used was made up of 4x4-in. timber, as shown in the left-hand sketch herewith. It was a short frame or tower adapted to run on wheels to move it along the trench, the sheetpile hammer being suspended through a chain block from a fixed hook in the top of the top of the frame. After this had been in use a short time a different type of frame, of steel construction, was built. This is shown by the right-hand sketch. Here the hammer is suspended from a trolley running on a longitudinal I-beam which forms the cap of two triangular bents; the frame is not mounted on wheels, but remains in place while the driver is moved along the 16- or 17-ft. length of beam. When this length has been covered the whole frame is picked up and shifted ahead.

The sketch shows the construction of both frames quite clearly and the manner of using them will be apparent. R. K. Smith, superintendent for the contractor on this job, supplied sketches of these rigs.



GANTRY FRAMES FOR SUPPORTING SHEETPILE HAMMER

Steel Bridgework in a Severe Fire

A graphic reminder of how destructive is the action of intense fire on structural steelwork is furnished by some views of wreckage of the Central Viaduct and the Nickel Plate railway viaduct at Cleveland. These two viaducts were wrecked on May 25, 1914, by a fire in a lumber yard beneath. A description of the fire and the damage done to the viaducts was published in ENGINEERING NEWS, June 4, 1914, p. 1269, in an article by C. E. Drayer.

Fig. 1 shows a crumpled leg of tower 29-30 of the Central Viaduct. This was pulled out of the ground by the wrecking gang after the iron which had fallen on top of it had been cleared away. Its appearance tends to support the theory that an overheated tower leg initiated the collapse of the viaduct.

Fig. 2 is a view on the deck of the Nickel Plate Viaduct at tower 5. Here the heat was at its greatest intensity. The extreme distortion of girders and bracing shows strikingly.

NOTES

A New Pile Formula which takes into account the relation between the weight of the pile and of the pile hammer, has recently been adopted by R. A. Cummings, Pittsburgh, Penn., in some concrete-pile work in Pitsburgh. The formula is purely empirical and is a development of the "Engineering News" formula, substituting the ratio between weight of pile and weight of hammer for unity in the denominator of that formula. The Cummings formula thus stands:

$$P = \frac{2\,Wh}{s\left(1 + \frac{w}{W}\right)}$$

where

P = Safe load in lb.;
W = Weight of hammer in lb.;
h = Drop of hammer in ft.;
s = Final penetration in in.;
w = Weight of pile in lb.

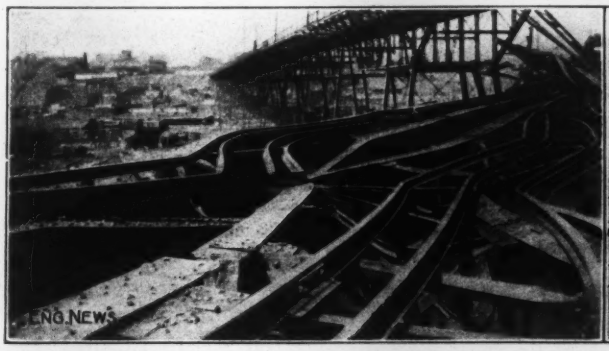


FIG. 1. TOWER LEG OF CENTRAL VIADUCT

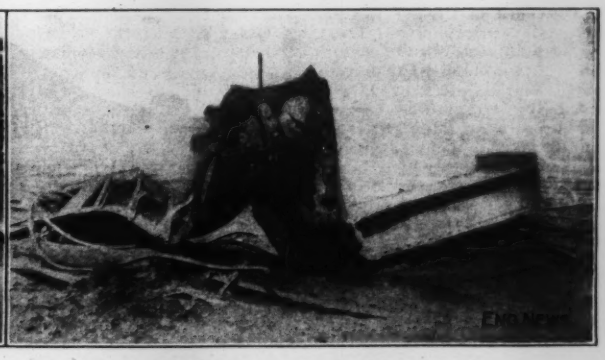
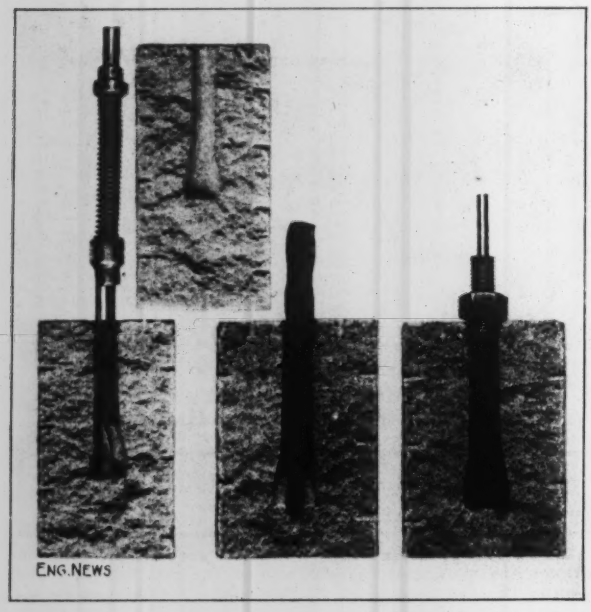


FIG. 2. DECK OF NICKEL PLATE VIADUCT

EFFECTS OF FIRE ON STEEL BRIDGEWORK

(Photographs by G. H. Tinker, Bridge Engineer, N. Y. C. & St. L. Ry.)

Chambering Tool for Anchor-Bolt Holes in masonry has been invented by A. Sanford Craven, 3321 North Bouvier St., Philadelphia, and is shown in the accompanying figure. The hole in the stone block was made with an ordinary star drill, enlarged at the bottom with the Craven offset chisel and then the block was split. A scheme is also shown in the same figure for anchoring ordinary reinforcing bars where it is desired to secure new masonry to old. For fastening shaft hangers to a thin wall or ceiling, where the depth of material beyond the bottom of the hole is too little to withstand the seating blow for an ordinary wedge belt, the hollow steel bolt shown has been devised. This is made from steel tubing with one end threaded and the other backed up solid and slotted. The ends are spread by driving a pin down into the hollow bolt. The force of the blow is transmitted to the face of the wall by the nut and there is no impact on the bottom of the hole.



CHAMBERING TOOL INVENTED BY A. SANFORD CRAVEN

The chambering tool has its end bent out and its cutting edge shaped like a blunt gouge. The chisel passes loosely through a collar on a guide bar and is fastened to it by a spiral spring. It is obvious that when the chisel is struck, the guide bar will thrust the cutting point into the side of the hole. The spring lifts the chisel after each blow. When one side is sufficiently enlarged, the guide with the chisel is turned around so that the other side can be attacked. It is claimed that one of these tools will chamber out a ⅝-in. drill hole with 14 blows of a 2-lb. hammer.

A Record in Precise Leveling—During the month of July, 1914, a leveling party of the U. S. Coast & Geodetic Survey, under the direction of Assistant J. H. Peters, made a remarkable run in Idaho and Montana. The progress of the party was 120 miles, and each mile was leveled over at least twice. The total leveling done by the party during the month amounted to 240 miles, with 3,456 setups of the instrument. The leveling was done on 21 working days. The total observing time was 152 hr., which is made up of the interval of time each day between the first and last observations, omitting the hour for lunch, about 7 hr. The average time at a station was 2.6 min., and the average length of sight was 61 m.

The greatest number of setups of the instrument in any one day was 214, in 9 hr., while the maximum progress made in any one day was 20 miles of single line is 7.7 hr.

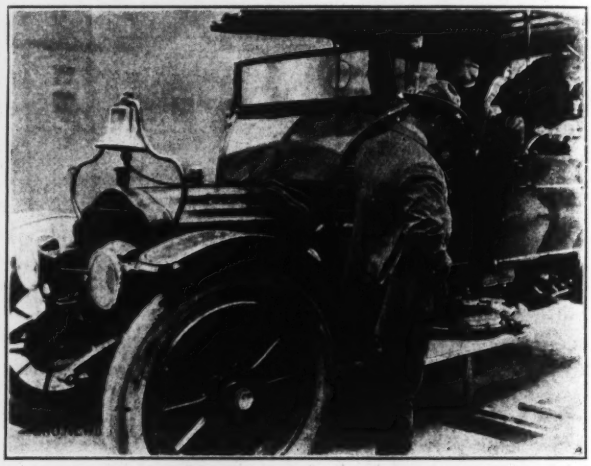
The line was run along the railroad and the means of transportation to and from the quarters of the party were velocipede motor cars. These cars were also used during the actual leveling.

The leveling party consisted of one observer, one recorder, two rodmen, one windshield man, and one sunshade man. The instrument used is the new Coast & Geodetic Survey precise level, which is described in detail in Appendix 3 of the Report of the Coast & Geodetic Survey for 1903*.

The previous record in precise leveling for any one calendar month was 112 miles of progress, which was made by Assistant J. B. Miller in 1905. His total length of single line was 242 mi [Contributed by F. W. Perkins, Assistant Superintendent, U. S. Coast & Geodetic Survey.]

The Need of Heavier Pavement Foundations—I think on the streets that will be subjected to the heavy traffic, it will undoubtedly be necessary in the future, if motor trucks are to be continued with heavy loads, as they undoubtedly will, to lay heavier foundations on streets that will be subjected to that traffic. It may be necessary in the large cities to have certain streets assigned for those heavy trucks. I do not think it is fair to a city or the property owners to be compelled to lay pavements with a strength sufficient to hold up those heavy loads. I was surprised to find in Glasgow that even under the heaviest traffic conditions, they did not use more than 6 in. of concrete foundation, but in London, on the heavy traffic streets, they are using 8 in. If we are going to have these enormous loads, as we undoubtedly are, some special provisions must be made for them.—George W. Tillson, consulting Engineer of the Borough of Brooklyn, New York City, in a discussion before the Cleveland Engineering Society, May 16, 1914.

Automobile Attachment for Opening Water-Main Valves—There has been a demand for the more rapid closing of water-main valves in cases of fire or break than could be secured by hand. One of the first devices for this service, designed to be attached to one of the rear wheels of a motor vehicle, was shown in "Engineering News," Feb. 5, 1914. A different arrangement is shown in the accompanying figure; it was devised by G. H. Finneran, Superintendent of Distribution, Boston Water Department, and built by the White Co., of Cleveland, Ohio, to be used on an emergency motor wagon supplied by them to the City of Boston. A wrench socket with vertical stem is connected by a universal joint to a worm-gear drive operated from the main transmission shaft. Forward motion is used for closing the valve and reverse motion for opening. Control is by a special lever on the truck side working a clutch. The gear, worm and shaft are inclosed in a strong aluminum housing fastened to the chassis frame to withstand torque stresses, but located over the running board for accessibility. The gears are of chrome nickel steel; ball bearings are used throughout. The wrench is a square hollow steel rod with a hard-steel stem socket fastened to the end by a universal joint. By having these two universal joints, on the upper and lower sockets respectively, careful alignment of the wrench and valves is not necessary. To protect valves not having position indicator the wrench is designed to break the pin of one of the universal joints before the valve could be damaged by turning after the end position is reached. It is claimed that a valve which formerly required four men 45 minutes to close it can be closed in 10 minutes with the truck.



AUTOMOBILE ATTACHMENT FOR OPENING STREET MAIN VALVES

*See "Engineering News," July 2, 1903, p. 2; Mar. 23, 1911, p. 356.

Editorials

Evil of Exempting Municipal Utilities from Commission Regulation

We have referred in these columns at various times to the need of placing municipally owned utilities on the same basis as privately owned plants under the supervision of public-utility commissions. One of the latest illustrations of economic loss from duplication of plants, is seen underlying the recent decision of the New York Commission for the Second District, granting the village of Bath authority to construct a municipal electric-light plant. The application to the commission was opposed by the local company, but the report of the commission shows that the authority of the commission was needed only when the village plant should do other than purely public business. The work of constructing the plant had been largely completed and all the commission could do would be to prevent the town from supplying private customers. But the service of the local company was unsatisfactory and could be made only worse without the village's business. The commission was faced with the unfortunate alternative of either having a private company for the private consumers and a public utility for the public load, with inferior service to both, or allowing the municipality to take on the private customers and compel it to give them good service. Had the commission full jurisdiction over the municipal plant from the start, it would have prevented the duplication of work and compelled the private company to give adequate service. The commission recommended that the town purchase the plant of the private company, but the temper of the people is not such as to make that outcome probable.

⁂

A Superficially Fireproof Pier

The Philadelphia & Reading Ry. pier fire at Philadelphia, described on another page in this issue, is the fifth destructive pier fire of the year. Already during 1914 the ports of Seattle and Portland on the Pacific, and Glasgow and Portsmouth in Great Britain have suffered considerable loss from the burning up of the structure and contents of wharves. The inflammable contents of the usual warehouse pier, the wide open spaces and the difficulties in fire-fighting, all seem to join together to make particularly destructive any fire which gets a fair start. The four previous fires were in structures which laid no especial claim to being fireproof, so they made particularly good texts from which to preach the necessity for a fireproof construction in all pier and harbor work. The lesson from the Philadelphia fire is somewhat different.

To the untrained eye the Philadelphia pier appeared to be fireproof. It was of steel structure and it had a concrete facade showing from the street. In reality in the condition in which it was last week it was anything but fireproof. The surrounding of the steel columns by concrete had not reached above the floor, and the steel and concrete shell was made practically useless as fireproofing by the presence of a wooden interior balcony and an inflammable, or at least burnable, roof. Finally, there did not appear to have been any attempt to install a sprinkler system of protection.

The fire emphasized the fact that a fireproof building is not a building in which some of the units or members are fire-resisting. It is rather a well designed whole, consisting of individual fire-resisting members so placed as to make extremely difficult the starting of a fire, so built as to succumb but slowly to the attacks of the fire once started, and so protected as to put out the beginning at least of any fire which may evade the first line of protection in arrangement and construction.

The Philadelphia pier was not complete, so any criticism of its construction must be withheld. It should be widely recognized, however, that the building was not a fireproof building in any sense of the word and that its destruction by the fire is no reflection on fireproof buildings or on the quality of concrete and properly protected steel in fireproof structures.

⁂

Elevator Gate Accidents in New York City

In remarking, in our issue of Oct. 15, upon the grave dangers to life and limb that lurk at unguarded elevator entrances, we called attention to the multitude of very obvious examples in New York City. This has been strikingly confirmed by figures secured by the Department of Buildings for Rudolph P. Miller, Engineer in Charge of Building-Code Revision for the Board of Aldermen. In the five years 1907-1911, for which records were available, there were 207 fatal accidents—119 on passenger elevators and 88 on freight lifts. Of these, 80% were at shaftings and were preventable. These preventable accidents are well distributed—three in private houses, 19 in apartments, 12 in hotels and clubs, 30 in office buildings, 8 in stores and 23 in factories or lofts. Looked at from another angle, 36 were in buildings six stories high or less; 39 were in buildings of seven to twelve stories, and 20 were where the height was over twenty stories. These are accidents in which fatalities occurred and are not the actual number of deaths, which is somewhat larger. If the same ratios of death to injury prevail here as throughout the country, there were probably nearly two times as many persons injured as were killed.

This situation we should note, however, is one that is being heeded by the present city administration. If the efforts now underway are successfully completed, New York should become a great model of safety in this regard instead of the notorious example of danger.

In the revision of the building code, under the direction of Mr. Miller, it is aimed to incorporate provisions requiring the interlocking of elevator cars and shaft doors so that no shaft gate or door can be opened until the elevator has come to stop at the landing and so that the

car cannot be moved while the door is open. There are some 10,000 elevators in Manhattan alone, with about 100,000 openings. It is planned to spread the required installation of safety interlocks from Jan. 1, 1915, to Apr. 1, 1917, high-lift and high-speed elevators being attended to first.

As proposed up to the present, the use of safety gates inside the cars is not to be made a part of the statute, but is to be covered by rules and regulations of the superintendents of buildings. The most rigid requirements are directed against elevators used for the carrying of persons other than those necessary for safe operation; this includes the majority of so called freight elevators in the city.

The code provisions, however, as proposed, will go even further. Before the elevators can be installed, erected or altered they must be inspected and licensed. It is also proposed to have them inspected at least once in each three months though, to prevent duplicated effort and to lessen the burden of cost to the city, the certificates of inspection by casualty insurance companies are to be accepted in lieu city inspection. The operator must be competent, experienced and licensed. All accidents are to be promptly reported to the superintendent of buildings, with penalties for failure.

Government Operations at the Panama Canal

Engineers who visited the Panama Canal during its construction were particularly impressed by the fact that the United States, through its engineers, was not only carrying on the actual work of digging the canal by the direct employment of labor without the intervention of any contractor, and was carying on the civil government of the Canal Zone, but was also carrying on practically all the commercial work required for the supply of the Zone's population.

The commissary stores where the canal employees bought their food, clothing and other supplies were conducted by the army quartermasters and effected an enormous saving to the employees over what would have been necessary had the private enterprise of the merchants of Panama been the sole reliance for supplying the workman's needs.

Now that the canal has been completed and put into operation, however, it has been found to be necessary that the United States shall continue this work for the benefit of the vessels making use of the canal, as well as for the permanent population of the Zone. Thus, at Panama, the United States is not only operating its canal for the use of the world's shipping, but is keeping store, keeping hotel, running laundries, ice plants, coal depots, oil depots, machine shops and various other commercial enterprises. The government buys coal from the fields of Virginia and West Virginia, transports it to the Isthmus, and sells it at Cristobal at from $5.15 to $5.40 per ton, according to the manner in which it is delivered to the ships—whether from a lighter or alongside the wharf. At Balboa, on the Pacific side of the Isthmus, the price is $1 per ton higher, which is stated to be on account of the cost of transportation of the coal across the Isthmus. This would be at the rate of 2c. per ton per mile for the 50-mile haul—a very liberal figure for transportation cost. Probably this high differential is fixed so that ships passing through the canal will take their supply at Cristobal instead of Balboa, but it brings the coal to rather a high figure for vessels sailing north or south on the Pacific and putting into Balboa for coal without passing through the canal.

Vessels desiring fuel oil can get it at Balboa at present from the Union Oil Co. at $1.30 per barrel; but the government itself will handle the business as soon as its oil-handling plant is completed in January next.

The commissary department of the Panama Canal is now supplying regularly most of the food and wearing apparel used by a population of 50,000 people. These commissary stores are available for the use of ships passing through the canal. The prices charged are generally lower than retail prices in the United States. A large stock of fresh meat, vegetables, fruits, canned groceries, etc., is always kept on hand; and by making advance arrangements, ships can obtain supplies of any article obtainable in the markets of the world. The government laundries are equipped to handle the entire laundry work of a ship in one day's time, so that by forwarding the laundry work by rail from one terminal of the canal to the opposite terminal as soon as the ship arrives in port, the laundry will be ready by the time the ship is ready to clear from the opposite end. The canal repair shops are equipped to do any sort of ship-repair work, and the permanent dry dock, now under construction at Balboa, is large enough to take any vessel that can pass through the canal. Prices of repair work are made on the basis of actual cost plus a percentage to cover overhead expenses.

This remarkable development at Panama, by which the government has undertaken the carrying on of industries and commerce on a large scale which are commonly carried on by private enterprise, has been found to be necessary at Panama to the business-like operation of the canal.

The United States has invested nearly $400,000,000 in a great transportation enterprise. In order to earn as much income as possible on this huge investment, it is necessary that the canal should be made as attractive as possible to the world's shipping. The ability to procure supplies, fuel and repairs for shipping at a reasonable price and to be sure of good service will be as important a factor in encouraging traffic to pass through the canal in preference to other possible routes as will be the safety of transit through the canal and the maintenance of toll rates at moderate figures.

It would, of course, have been possible for the government to have left wholly to private enterprise the sale to vessels of fuel, food, water, ice, laundry service and other essentials; but in this limited field it would have been doubtless but a short time before one concern would have secured a monopoly in these respective fields, and it would then have been necessary for the government to undertake the difficult work of regulating prices. It would have involved serious difficulties in dealing with merchants of various nationalities; and the regulation of the character of service rendered by the repair shops, for example, would have been as necessary as the regulation of prices.

This remarkable excursion of the government into the field of commerce and industry at Panama, therefore, has been undertaken as a matter of logical necessity. It is particularly noteworthy that it has been undertaken with-

out a hint of public criticism in the United States. The remarkable efficiency attained by Colonel Goethals and his associates in carrying on the canal work has in fact disarmed all criticism. We believe it is an aspect of the engineering work at Panama which deserves even more notice than it has received, and one in which the profession as a whole may take just pride.

Licensing Engineers in Pennsylvania

As reported in our last week's issue, the storm center of agitation concerning state legislation to restrict the practice of engineering appears to have removed from New York to Pennsylvania. A state commission of engineers was appointed by the Governor of Pennsylvania a year ago to consider the question whether state legislation regulating the practice of engineering was advisable in the public interest and this Commission is holding hearings in various cities. It may be of interest at this time briefly to review the agitation of this question in New York and elsewhere, and to indicate the present status of the movement.

In the Western States, legislation to restrict engineering practice has been under discussion for several years in the state engineering societies. A large proportion of the members of these state societies are chiefly interested in land-surveying work; and many of them have been impressed with the poor quality of the work done by many of the men who engage in land surveying and the laying out of drainage and irrigation ditches.

Many who have given careful study to this subject and who oppose any project to subject the entire engineering profession to a license law have freely recognized that there is something to be said for the proposal to subject engineers engaged in some specific branch of work, such as land surveying, to examination and registration. Those who employ surveyors to run farm boundaries, lay out drainage and irrigation ditches, etc., are not well qualified to determine whether a man is or is not competent to perform his work. There is, therefore, some reason for the state stepping in and requiring that those engaging in such tasks should have some minimum degree of qualification for their work. It is, moreover, practicable to determine the qualifications of men to engage in such work as surveying, which requires only a comparatively elementary knowledge of engineering and no very long period of practical experience.

The strongest impetus toward state legislation on this subject, however, came from an organization of engineering employees in New York known as the Technical League. The members of this organization were impressed with the idea that their positions might be bettered and their chances for promotion increased by restricting the practice of engineering to those having a certain minimum degree of education and experience. This organization employed counsel and had bills drafted and introduced in the New York Legislature. These bills, however, related to civil-engineering work solely. As the news went abroad of the introduction of these bills in the legislature, there was a general movement among the engineers of New York to protest against their enactment. Year after year delegations of engineers, including some of the most eminent men in the profession, went to Albany and appeared before the committee in charge of these bills to point out the injury that would result from their enactment. In every case these delegations were successful in having the bills killed by the committee. Not one was ever reported to the legislature.

There were, however, a certain number of engineers who felt that some legislation to regulate the practice of engineering, framed on proper lines, might be desirable. There was a larger number who, while they believed that any such legislation would be injurious, felt nevertheless that the pressure to enact such laws would prove in the end too strong to be resisted and that it was better therefore to undertake to frame a bill which would do as little injury as possible.

The first move in this direction was made by the American Society of Civil Engineers. At the annual meeting of this Society, in January, 1911, the members present by almost a unanimous vote, declared that any legislation restricting the practice of engineering was inadvisable. The meeting also, however, adopted the report of a committee of the society's Board of Direction containing a draft of a proposed model engineer's license law which required the licensing not merely of civil engineers but of every man who should undertake to practice professionally any branch of engineering whatsoever, outside of military engineering.

No progress was made, however, in New York or elsewhere toward the enactment of such a law, and in the New York legislature of 1911, 1912 and 1913 bills introduced for this purpose were killed in Committee.

There was organized, in 1913, a joint committee, made up of representatives from each of five of the national engineering societies, for the purpose of investigating the question of state legislation with reference to the practice of enginering, and determining whether an unobjectionable act could be drafted.

Radical differences of opinion developed in the committee as the work proceeded; and notwithstanding more or less mutual concessions, no final agreement on a completed report was ever reached. The principal work in connection with the committee was done by its chairman, the late Alfred Noble. After Mr. Noble's death, the whole matter was dropped.

Meanwhile, however, the changed situation in New York put quite a different face upon the movement to draft a model bill. It had been urged that the joint committee above referred to should complete its work in 1913 so that its bill might be ready for the legislature of 1914, to prevent the enactment of some bill of more injurious character. It developed, however, that the legislature of 1914 took no interest in the project to legislate on engineering practice. No bill on the subject was introduced in the legislature, and apparently the organization which had been so industrious in preparing and pushing bills in previous years had disappeared or had ceased to be active.

While the bill drafted by the joint committee above referred to was supposed to be in theory a model bill applicable to the conditions in any state, it was actually drafted with the conditions existing in New York as the controlling motive.

A copy of this bill was, however, placed in the hands of the Pennsylvania commission above referred to; and this commission, in order to draw discussion from the engineers of the state and have something tangible on which to base discussion, took this bill, redrafted it on

somewhat different lines, had it further revised by the bill-drafting experts employed by the State of Pennsylvania, and circulated it among the engineers of that state to obtain their opinions.

The result has been an expression of sentiment from leaders of the profession throughout Pennsylvania, which is, we understand, overwhelmingly against the proposed bill and for the most part against any legislation whatever restricting the practice of engineering. We printed in our last issue a statement by a committee of Philadelphia members of the American Society of Civil Engineers, headed by Prof. Edgar Marburg, giving in detail the reasons why such legislation is opposed.

Space does not permit us to print the numerous other strong letters and statements made by prominent engineers and by committees representing engineering societies in Pennsylvania. These statements, however, will doubtless be printed in full in the report of the Pennsylvania Commission, when that is made up.

The work of this Commission, therefore, will be exceedingly useful. It will doubtless again and again be necessary, in various states, for representative engineers to oppose legislation which seeks to hamper the profession with impracticable restrictions. Again and again in the past the question has arisen, where could a systematic presentation of the arguments against such legislation be found? It will be of great benefit to the profession to have the proceedings of the Pennsylvania State Commission and the testimony before it printed and made available for the use of engineers in other states.

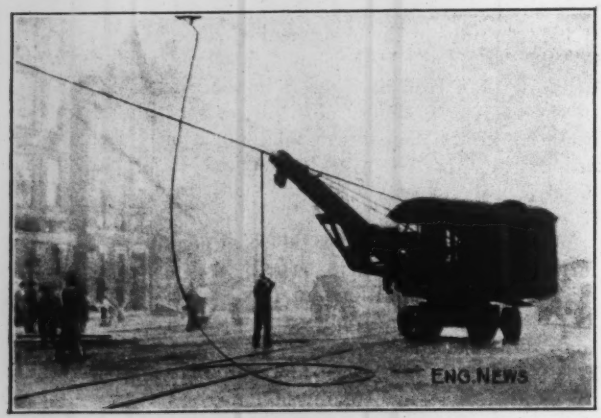
As to the general question of the advantage or disadvantage of legislation restricting the practice of engineering, this has been so fully discussed editorially in past volumes of this journal that it seems unnecessary to take further space at this time. However, it may be said that any attempt to draft a blanket law which will cover the entire work of the engineering profession will result in an unworkable scheme which would break down of its own weight, if it were placed on the statute book. If the practice of engineering is to be regulated by law it must be done by specifying some distinct branch of engineering work, which can be defined in the law, and for which the competency of an engineer can be determined.

In most departments of engineering work, however, it is wholly impracticable to safeguard the public by conducting state examinations of the engineers engaged in it. It is, for example, highly desirable that the public should be guarded from such disasters as boiler explosions. It would be impossible, however, to examine every engineer in the state who might design or construct a steam boiler, and determine his competency for the work, nor could such an examination reach the engineers designing and building boilers elsewhere for sale within the state. The only way the state can secure safe boilers within its borders is to pass such a law as that now being drafted by a committee of the American Society of Mechanical Engineers, specifying how boilers must be designed and built, operated and inspected.

Letters to the Editor

A Vagrant Steam Shovel

Sir—On a recent morning, while walking down Division St. near Ashland Ave., Chicago, I saw a steam shovel trying to cross Division St. The man operating the steam shovel ran the shovel right into a live trolley wire, which burnt off and fell sizzling and spitting to the street. Without losing any time, a helper grabbed a long pole, something like a clothesline pole, and held up the other trolley wire so that the steam shovel could go under it.



Lifting a Trolley Wire Out of Reach of Steam Shovel Boom in a Chicago Street

The whole thing was rather a nervy operation. In the first place the steam shovel ran into the trolley wire without any care at all, just as though no trolley wire was there. In the second place the way that fellow held up the trolley wire with the clothespole and let the steam shovel go under with not more than 2 in. clearance, was rather daring. If the steam shovel had caught the wire it would have burned off and dropped off right near him, and had it touched him it would have put him out of business. I got my camera out of my suitcase and snapped some views, one of which is shown herewith. When the steam shovel was out from under the second or northerly trolley wire it went up the street.

The one thing that impressed me more than anything else was the rank disregard these steam-shovel operators have for the trolley wires. There ought to be a severe penalty for such careless work.

B. A.

Chicago, Ill., Oct. 15, 1914.

Snow Removal by Artificial Heat

Sir—The method of removing snow by artificial heat suggested in the issue of the Engineering News of Oct. 1, 1914, by Samuel Whinery, is timely and novel; but it

seems to me the same results could be accomplished more readily by the use of direct heat and at much less cost per cubic yard.

Having given a little thought to this subject, I suggest the use of a kind of inverted muffle, mounted on wheels very similar to the apparatus which is used for local heating in making repairs to asphalt pavements. On the muffle could be mounted a tank for fuel oil, and an oil-driven pump could also be mounted on the truck for putting pressure on the tank.

With oil as fuel and directly applied heat, it is probable that 80% of the heat would be available, hence using Mr. Whinery's figures, 1600 B.t.u. would be sufficient to melt 1 cu.ft. of snow, or 13,550,000 B.t.u. would melt 317 cu.yd. At 19,000 B.t.u. per lb., there would be required 713 lb. of fuel, or about 96 gal., which, say, at 5c. per gal., would cost $4.80.

Now, as such a machine would probably be too large for a man to handle efficiently, suppose we consider one of twice that capacity drawn by a single horse; and further, suppose that such an apparatus would cost the same as the boiler, pump, etc., mentioned by Mr. Whinery, viz., $1300; then the cost per cu.yd. would figure out about as follows:

Fixed charges per day	$29.58
Fuel, 192 gal. at 5c. (delivered)	9.60
Driver and horse	6.00
Stoker or engineer	3.00
Laborer or trimmer	2.50
Miscellaneous	2.00
	$52.68

If 634 cu.ft. of snow were melted, the cost per cu.yd. would be ..... 8.30c.
To cover contingencies, add 10% ..... .83c.
9.13c.

Or, if we consider the heat efficiency at ⅔ as Mr. Whinery did, the cost would be 8.42 c. per cu.yd.

Of course, the idea might easily be expanded to a number of large machines drawn by a traction engine, or a number of large units each operated by oil or gas engines.

E. L. Broome, Mechanical Engineer.
General Reduction, Gas and By-Products Co.
49 Wall St., New York City, Oct. 21, 1914.

NOTES AND QUERIES

In the article entitled "Pipe Laying Methods on the Narrows Siphon of the Catskill Aqueduct," "Engineering News," Oct. 22, 1914, p. 812, mention was not made of the fact that Long & Miller, 172 Fulton St., New York City, are Consulting Engineers for the contractor, the Merritt-Chapman Derrick & Wrecking Co.

Building Levees with the Hydraulic Dredge

By Jean M. Allen*

In view of the large amount of levee work now contemplated and under construction, and the low cost claimed for the hydraulic fill system, a description of plant and methods used in building levees with hydraulic dredges may be of interest.†

*Consulting engineer, 1139 First National Bank Building, Chicago.

†A previous article on work of this character, by D. C. Yarnell, was published in "Engineering News," June 11, 1914. —Editor.

Discharge Pipe with Bottom Openings

Sand or gravel dredged by the hydraulic process is not carried entirely in suspension by the water in the discharge pipe, but the heavier material settles and flows along the bottom at a velocity much lower than the impelling water. This is specially true if the pipe line is long or the velocity of the discharge water is low. This action can be utilized to build embankments of as steep a slope as 1 on 1, directly from the discharge pipe.

This is accomplished by what are called "shutter pipes," which are lengths of ordinary slip-joint discharge pipe, generally made of No. 10 to 14 sheet steel and in lengths of from 16 to 18 ft., with openings in the bottom, as shown in Fig. 1. These openings are controlled by steel plates or shutters and may be opened or closed at will. A stretch of these pipes is laid on a trestle and the discharge pipe from the dredge is connected to them. When the shutters are opened the sand flows at about the consistency of thick mortar, building up into a steep embankment.

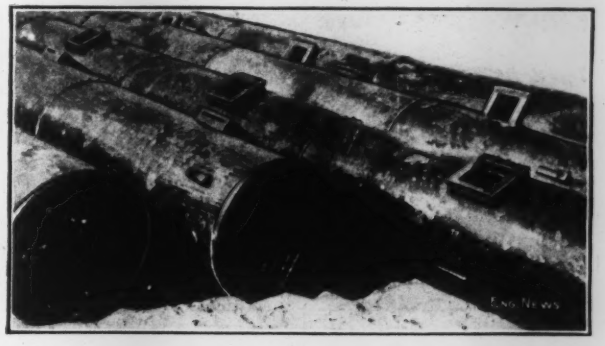


Fig. 1. 20-In. Shore Pipes for Hydraulic Dredge, with Bottom Discharge Openings for Building Levees

The discharge pipe is continued beyond the shutter pipe in order to carry away the surplus water and avoid washing down the levee which has been built. Fig. 2 shows this work and Fig. 3 shows a shutter for a 14-in. pipe. The shutters should be spaced 3 to 4 ft. apart, and should be attached to the pipe with chain or wire, otherwise many will be dropped into the fill and lost.

Dredging Plant for Levees

Many sizes and types of dredges have been used, with discharge pipes 12 to 20 in. diameter, and the cost of the complete plant is from $15,000 to $100,000. Both steam and electrically driven dredges are being used. Some have revolving cutters or water jets to disintegrate the material, but many have neither apparatus. This depends on the compactness of the material to be excavated. In general, any attempt to economize in first cost at the expense of construction or equipment of the dredge will be paid for dearly in subsequent breakdowns and loss of time.

California Dredges—Two powerful and efficient dredges for this class of work on the Sacramento River, are identical except that the "Natoma" is driven by steam and the "West Sacramento" by electricity. Both are built entirely of steel, having hulls 104x35x9 ft. The structural-steel ladder carrying the suction pipe is 50 ft. long, and is equipped with a rotary cutter.

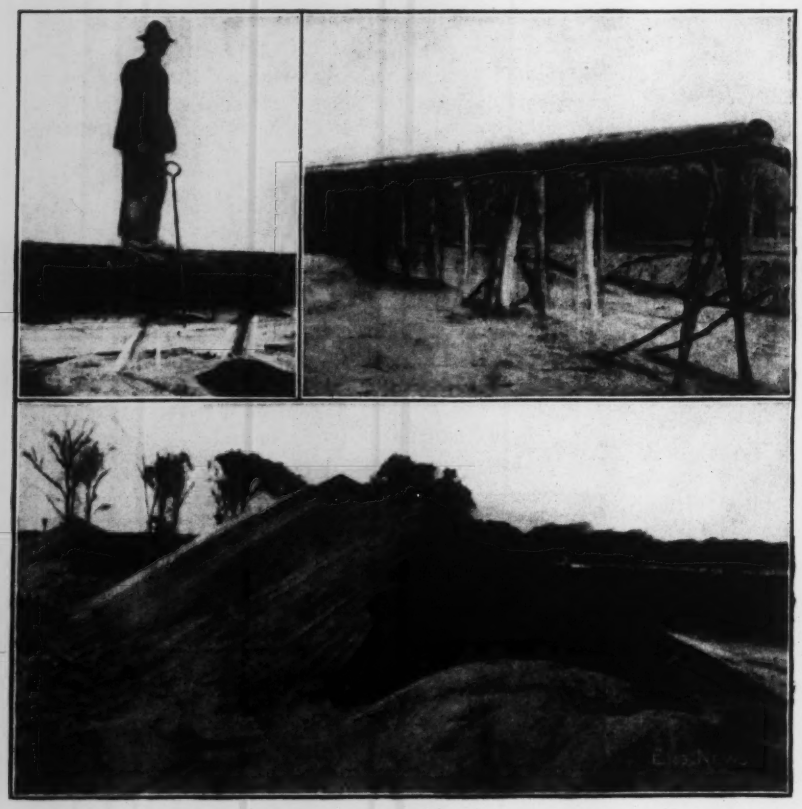


FIG. 2. DREDGE DISCHARGE PIPES WITH BOTTOM OPENINGS, AND FILL MADE IN THIS WAY FOR A LEVEE

The dredging pumps have 20-in. suction and discharge openings and are of nickel-chrome steel. The "Natoma" has a 74-in. runner, driven at 190 r.p.m. by a triple-expansion engine of about 600 hp. Steam at 160 lb. pressure is furnished by two water-tube boilers having a total heating surface of 4500 sq.ft. A double-cylinder 10x12-in. engine drives the cutter, and the winding machinery which handles the spuds and ladder and swings the dredge is operated by a double-cylinder 8x8-in. engine. A surface condenser receives the exhaust steam from all engines.

The 20-in. pump of the "West Sacramento" has a 50-in. runner and is driven by a 750-hp. motor whose speed may be varied between 300 and 350 r.p.m. The winding machinery has a 35-hp. motor, and the cutter a 150-hp. motor. Three-phase, 60-cycle, alternating current, at 11,000 volts, is brought aboard by a submarine cable and stepped down to 2200 volts.

The cost of the "Natoma" was $105,000, including pontoon line and shore pipe, and the cost of the "West Sacramento" was $85,000. The former has deposited several million yards at an average cost of 6.6c. per cu.yd. After the work was thoroughly organized the average monthly output was about 200,000 cu.yd. per month, and the record for one month 248,000 cu.yd. The dredge was operated 24 hr. a day and 6 days a week, with 6 men per shift on the dredge and about 16 men per shift to handle the pipe line.

MISSISSIPPI AND MISSOURI RIVER DREDGES—On these rivers, 12- and 15-in. dredges are used, due no doubt to the reluctance of the contractor to build an expensive plant for the small yardage in the contracts offered. Larger machines will hardly be built until projects of greater magnitude are brought forward or unless a great amount of filling is to be done in connection with the levee work.

For a 12-in. dredge, a hull about 80x 24x4½ ft. is ample, as the character of the material does not require rotary cutters or heavy suction ladders. The pump is generally belt driven. The ordinary sand and gravel pump of cast-iron construction is not satisfactory, as the abrasive character of the river sand wears cast-iron pump parts with great rapidity; and with pumps having renewable liners there is loss of time in keeping the liners in place and renewing them. The best pump for this kind of dredging is of special design and massive construction, with the shell and runner made of manganese or other special steel. While its first cost is greater, it effects a great saving of operating time, thus increasing the output.

A steam-driven dredge with 12-in. pump should have an engine of 150 to 250 hp. The power for any particular installation is a matter for calculation, taking into consideration the height of discharge, length of line, number of elbows, etc.; also the character of the material to be pumped, which determines the requisite velocity of the water in the discharge pipe. The transmission may be either a leather or a rubber belt or a rope drive, the latter having been found very satisfactory for this duty.

The boilers should be of the externally fired type with large mud drums, both the cylindrical and the Mississippi River types being in general use. The locomotive boiler is not particularly adapted to this work on account of the general turbidity of the feed water. Even boilers of the river type with large mud drums, and frequently blown down, must be washed out every few days. Few of

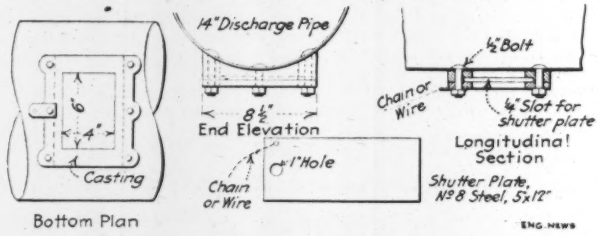


FIG. 3. BOTTOM DISCHARGE GATES FOR SHORE PIPES OF HYDRAULIC DREDGE

these dredges have been equipped with surface condensers, but their use would result in a large saving of time in boiler washing and repairs.

These dredges, working in swift rivers, are held in position by anchors and cables rather than spuds, and require very little maneuvering to maintain an adequate

supply of sand to the suction pipe. The current keeps the bottom of the river constantly in motion and the material excavated is rapidly replaced by this movement. Instances are common where dredges have pumped for weeks without moving the suction pipe. Thus little winding machinery is required. A double-cylinder single-drum hoist of about 20 hp. is used to raise and lower the suction pipe while the dredge is maneuvered by taking the anchor cables to the winch heads.

The total cost of a 12-in. plant, complete with pipe line, is between $15,000 and $25,000, depending upon the class of machinery and the refinement of construction. Between 25,000 and 50,000 cu.yd. per month would be the probable output, depending upon the length of the pipe line, the layout of the work, river conditions and the skill of the operators.

The dredge with 15-in. pump is built along the same lines as the 12-in., though frequently the pump is directly connected rather than belt driven. In either case, the engine should be compound, to save fuel. Between 250 and 300 hp. is required for a plant of this size, depending upon the conditions mentioned. An efficient engine for medium power is a cross-compound of either the horizontal or marine type. The boilers should have about 2500 sq.ft. of heating surface. If surface condensers are installed, water-tube boilers may be used, otherwise the Mississippi River type is to be preferred. A donkey boiler should be provided for washing the main battery. A hoisting engine handles the suction pipe, but it is desirable to have a deck capstan with independent engines for handling the boat.

The suction pipe is articulated at the end of the dredge either by a swivel elbow or merely by a length of suction hose, and is raised and lowered by tackle suspended from an A-frame over the bow. Its lower end is provided with a suction nozzle, consisting of a cone-shaped head with cross-bars to prevent the entrance of large stones and pieces of wood that would clog the pump. The hull will be about 110x30x5 ft. The 15-in. dredge, complete with all equipment, will cost between $25,000 and $45,000 and its output will be from 60,000 to 125,000 cu.yd. per month. To attain the latter figure, the conditions must be very favorable and the dredge must be operated continuously (24 hr. a day) and with very few delays.

Levee Construction with Dredge

The maximum monthly output of which a dredge is capable is rarely attained in levee work, on account of the large percentage of time lost in shifting pipe, and it is of great importance that experienced men be employed, to reduce this loss to a minimum. As the shutter pipes have to be shifted ahead as each section of the levee is completed, it is advisable to so plan the work that operations can be conducted on two sections simultaneously. The main discharge pipe is provided with a Y-branch and gate valves so that the filling can progress on each section alternately, thus reducing the idle time of the dredge. If this is not possible, sometimes the levee is brought up to the full height but not to full width at the first operation, and then widened with the branch line while extending the main line.

Some contractors use a discharge pipe of larger size than the pump and suction; for instance, an 18-in. discharge pipe for a 15-in. pump, with 15-in. suction pipe. The purpose is to save power by reducing the velocity of water in the line and thus the friction head pumped against. But it is the velocity rather than the quantity of the water that is instrumental in keeping in suspension and transporting such heavy material as coarse sand and gravel. Enlarging the discharge pipe reduces the velocity and causes the sand to settle until the cross-section is reduced and the velocity thus increased to a point where it will again carry the material.

It is better practice to use a discharge pipe of the same size as the pump as far as it connects with the shutter pipe. There it may be enlarged, as it is desired that the sand should settle so that it may be discharged through the shutters. In a high-powered 20-in. dredge on the New York Barge Canal, difficulty was experienced in pumping gravel and small boulders through a long 20-in. discharge line, but upon replacing this with a 16-in. line the material was discharged with ease and the output greatly increased.

Shields or slope-boards, consisting of plates of No. 16 steel about 10 ft. long and 18 in. wide, are frequently used to facilitate the formation of the desired slope. A number of these are inserted, end to end, in the partly formed slope. They prevent the sand from flowing downward until it fills to the top of the plates, when they are pulled out and moved further up the slope.

The hydraulic construction of levees requires considerable skill. The suction-pipe operator must keep a steady and uniform flow of sand in the discharge pipe, and the pipe men must use judgment in opening and closing the shutters to build the embankment to the proper slope; closing some of them if the percentage of sand in the pipe decreases and opening enough of them to discharge water if the slopes need to be flattened out. The handling of the slope boards also requires practice. With a good reliable plant, properly designed to meet local conditions, some remarkable results have been obtained, not only in the low cost per yard but in the character and appearance of the fill.

The operating costs given in the accompanying table are typical for a 15-in. dredge on the Mississippi River,

MONTHLY OPERATING COST—15-IN. HYDRAULIC DREDGE

1	foreman	$150
1	engineman	125
1	engineman	100
2	suction operators, at $100	200
2	oilers, at $60	120
2	firemen, at $70	140
2	coal passers, at $60	120
3	deck hands, at $60	180
1	levee foreman (day)	90
1	levee foreman (night)	70
10	levee laborers, at $60	600
26	Total labor cost per month	$1895
	Coal (18 tons per day)	1200
	Supplies (rope, oil, packing)	150
	Repairs and renewals	200
	Office and overhead expenses	200
	Insurance (fire and liability)	100
	Interest and depreciation (2% on $35,000)	700
	Total operating cost per month	$4445

working two 12-hr. shifts. The wages given do not include subsistence. Assuming an output of 75,000 yd. per month the cost is about 6c. per yd.

⁂

Division Engineers of the New York State Highway Department have been directed in submitting estimates for construction to include hereafter an approximation of the number of working days required to complete each contract. This, it is expected will enable the Highway Department to specify time limits on contracts more accurately, as the local engineers who work up the field notes are unquestionably in a better position to weigh carefully the elements which enter into the building of a piece of road than the office force are.

Failure of a Basement Retaining Wall During Construction

By Henry Blood*

On Oct. 7, a portion of the Morrison St. retaining wall of the new Meier & Frank department store, in Portland, Ore., collapsed, causing the street to cave in for a length of 62 ft. and flooding the excavation with water.

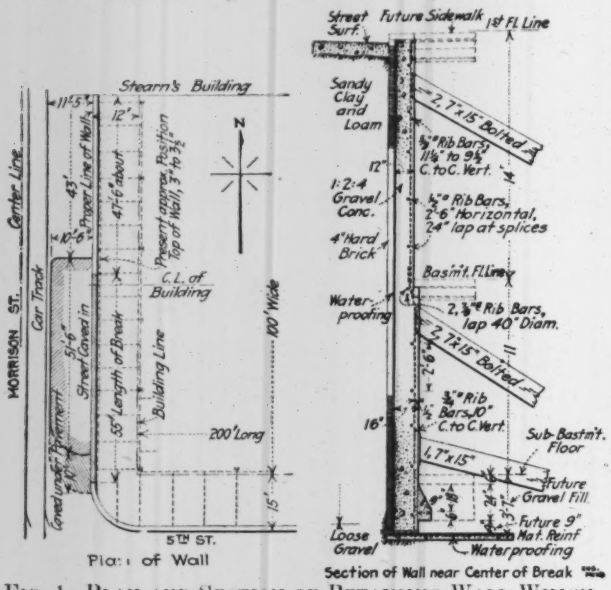


Fig. 1. Plan and Section of Retaining Wall Which Failed at Portland, Ore.

The building is under construction. It will be 100x200 ft. in plan, of steel-frame construction, with reinforced-concrete floor slabs, and will have a basement and sub-basement, both to be used for mercantile purposes. The basement space is 115x224 ft. outside dimensions. The height of the sub-basement is 11 ft.; that of the basement is 14 ft. The sub-basement floor is laid directly on the soil, which consists of good gravel. It is to be composed of a 4-in. plain slab laid on the soil, and carefully leveled on top for the waterproofing, a 9-in. reinforced mat on the waterproofing, 2 ft. of gravel fill, and finally 6 in. of concrete with wood sleepers and a wood floor. Only the 4-in. slab on the earth had been laid at the time of the collapse.

The wall was designed as a vertical slab with vertical reinforcing, to be held against the lateral pressure of the street fill by the sub-basement, basement floors, and sidewalk. It varies from 16 in. in thickness below the basement floor to 12 in. at the top, the reinforcing varying as shown in the section through the wall in Fig. 1. The concrete is a 1:2:4 mix. It was about six weeks old at the bottom and four weeks at the top, at the time of accident. On the outside of the walls there is a layer of waterproofing membrane and 4 in. of hard brick. This may be seen in the view taken from the street (Fig. 4).

The wall is 27 ft. high at the east building line, on Morrison St., 33 ft. at the west end and about 28 ft. at the center of the break. It was braced with three lines of shores, one above the other, spaced about 12 ft. apart horizontally. The upper two rows consist of two 7x15-in. seasoned Douglas-fir sticks, bolted together and well braced laterally. They show clearly in the views in Figs. 2 and 3. The upper end is set into the concrete about an inch, and the lower end firmly held. The center of the upper shores is from 3 to 4 ft. below the top of wall; the middle row hardly half way up the wall. The lower set of braces was made of single 7x15-in. timbers and simply placed to bear against the wall with thin pieces of plank between them and the wall, relying on friction to hold them in place. They are from 4 ft. 9 in. to 5 ft. above the bottom of wall still standing, and inclined at an angle of approximately 15° to the horizontal. It could not be ascertained whether there were any at the point where the break occurred, but the superintendent states that there were.

There is a 6-in. water main and a 20-in. glazed tile sewer

*Bureau of Buildings, City Hall, Portland, Ore.

Fig. 2. Near View from the Inside, Showing Bracing and the Bottom of Wall Which Failed

FIG. 3. VIEW TAKEN DAY AFTER FAILURE, SHOWING BROKEN WALL AT BOTTOM

on this side of the street. The sewer is about 11 ft. below the street opposite the break.

The inspector for the architects stated that the wall had moved in 1½ to 2 in. at the point of failure about Sept. 18. The pavement began to settle slightly, and readings were taken by the Department of Public Works on the 25th and 28th, showing a maximum settlement of 1¾ in. Later it was reported that the sewer was leaking, and a crew was sent on Oct. 2 to uncover and repair it. A trench was made close to the outer rail of the car track, as the sewer lies in this position. It was found that a settlement of about 9 in. had occurred at the worst point. The trench had not been refilled and its vertical side may be seen in Fig. 4.

FIG. 4. LOOKING ALONGSIDE MORRISON ST. AFTER COLLAPSE

(Brick outside facing of concrete wall on right; sewer trench cut on left.)

Water coming over the wall, according to the superintendent's statement, and cracks opening in its lower portion, gave the workmen sufficient warning to escape. An irregular piece of wall about 55 ft. long and 17 ft. high at the highest point was torn loose and forced inward, the movement beginning at the bottom of the wall (Fig. 3); it lay on a heap of earth and timber with the bottom edge about 20 ft. from the wall. The reinforcing rods pulled out where they were lapped at the basement-floor line, and large cracks were formed in the surrounding wall. The street caved in from the wall to nearer car track for a length of 62 ft., beginning 43 ft. from the west end of building, leaving a deep hole. The pavement dropped in for 51 ft. 6 in. (Fig. 4). Before the water main could be shut off it had let 2 ft. of water into the excavation. Car service in front of the site had to be discontinued, and cannot be resumed for some time yet.

At the time of accident no floor framing or any steelwork was in place; the sub-basement floor, gravel fill, and 9-in. mat had not been placed; and the wall simply stood on the waterproofiing, with nothing on the lot side to resist pressure from the street fill except the struts. It can be seen by reference to the wall section that there was no steel to resist stresses due to cantilever action. The wall was not designed for such action; but was entirely safe as a slab for a heavy earth pressure, even at the age it had reached. The concrete was good and steel accurately placed. It will also be noted that there were no horizontal timbers along the wall.

A large portion of the wall will have to be rebuilt. It is quite probable that the entire Morrison St. end will be replaced. The new wall will be made somewhat heavier. It will not be put in until the mat is all in place, and of sufficient age to be used for support. The bottom will then be held with horizontal shores. The bracing will probably be set closer together, and the lower ends will have a firmer seat in the mat than was the case when the accident occurred.

The accompanying photographs were made by the Department of Public Works. In connection with the drawing they illustrate the conditions quite clearly.

The Savings of Electric Traction over steam on the Butte, Anaconda & Pacific Ry. (described in "Engineering News," Aug. 15, 1912, Mar. 19, Apr. 2, and June 2, 1914), were reported at a meeting of the American Institute of Electrical Engineers in Spokane, Sept. 9, 1914, by J. B. Cox. The number of trains had decreased 25% but 35% more tonnage was hauled per train. Repairs had dropped 26% and engine-house expenses 38%. For energy alone $150,727 was saved. The reduction in trainmen's wages was $31,146. The total cost of conversion to electric traction was $1,201,000, making the total savings some 20% on the cost.

A Storm on Lake Michigan, Oct. 24, marooned 11 workmen on the intake crib of the new water-works intake for the city of Milwaukee. They were rescued by a member of the United States Life Saving crew, who swam out to them from a motorboat with a life line. On Apr. 20, 1893, 21 men lost their lives on a water-works crib under construction on the Milwaukee waterfront. Information regarding the recent storm came to us after the note by Mr. Warren printed on p. 897.

How Fire Wrecks Unprotected Structural Steel

We briefly described on p. 862 of our last week's issue the burning of a new pier shed of the Philadelphia & Reading Ry. on the Delaware River at Philadelphia on the evening of Oct. 15. The accompanying upper view shows a photograph of the interior of the wrecked pier, looking toward the street, and the lower view shows the reinforced-concrete front from the street side. The lesson has been many times impressed on the engineering profession that steel structural members, unless protected by fireproofing material, are much more vulnerable to the attack of flames than are heavy wooden posts and beams. The wreck of this pier shed is simply another illustration of the same fact.

Below the floor level the pier was a substantial concrete structure with a concrete floor, and the fire left it practically uninjured. The entire steel superstructure, however, was in a very few minutes converted into a mass of tangled scrap exceedingly difficult and expensive to cut up and remove. The work is being accomplished with the aid of oxy-acetylene torches.

The fact that a solid wooden post resists fire far better than bare steel is again well illustrated at one point on this pier where a short wooden post about 10 in. square, used as some temporary support, was in place at the time of the fire. The outside of this post was charred only to the depth of half to three-quarters of an inch, and the balance of the post cross-section was sound and uninjured. As most of our readers are aware, it was this substantial resistance to fire of solid wooden posts and beams which brought the New England factory slow-burning method of construction into being.

While the steel pier shed had been completed and a small amount of freight had been stored on the pier at

INTERIOR AND EXTERIOR VIEWS OF BURNED PHILADELPHIA & READING R.R. PIER, PHILADELPHIA

the time the fire occurred, the reinforced-concrete front of the pier, facing on Delaware Ave., still lacked a few days' work of completion. At one end, some of the forms were still in place, while the concrete protection of the steelwork at the central arch portal had not yet been poured. This reinforced concrete withstood the exposure in admirable fashion, as may be judged from the accompanying photograph. It is noteworthy also that the row of small windows above the projecting canopy roof framework on the left-hand side, seen in the background in Fig. 2, had been filled with wired glass. This glass had been heated so intensely as to render it opaque, but every pane remained intact throughout the fire.

Difficulties Being Met in Constructing the New Intake Tunnel at Milwaukee

By Lee G. Warren*

In the prosecution of the construction of the Linwood Avenue Intake Tunnel, under Lake Michigan, at Milwaukee, Wis., which was described in Engineering News, June 18, 1914, p. 1364, two recent and very serious collapses of the unlined roof have occurred. This tunnel, which is being built to give an increased water-supply for the city, has a circular cross-section, 12 ft. inside diameter, 15 ft. outside diameter. The lining is reinforced concrete having 1:2:4 proportion, the reinforcing being ¾-in. round steel bars. The tunnel when completed will have a length of 4000 ft.

Since June 1 of this year, or at Sta. 18+00, the contractor had encountered firm shale, having little difficulty in holding the roof, while advancing the heading on a daily average of 10 ft. But on Sept. 27, the unlined roof collapsed at Sta. 27+95 to 28+04, carrying down four 12x12-in. roof timbers, set at 4-ft. intervals. The hole resulting was 15x9 ft. at the bottom, 7x8 ft. at the top, and 15 ft. high, above the roof timbers. The material coming from the hole consisted of gravel, boulders, saturated clay and disintegrated shale, the quantity of water being very small. None of the workmen was injured, as a preliminary warning was given by the cracking and scaling off from the roof, and the settling of the timbers. The fall was caused, no doubt, by the saturated condition of this pocket and by the consequent overloading of the timbers. The nearest borings, 1100 ft. distant, showed shale at the depth at which the collapse occurred, 38 ft. below the lake bottom. The depth of the lake at this point is 30 ft. The roof timbers were replaced and the hole at the point of collapse was tightly packed with cribbing, after a 36-hr. battle to install them. An examination of the strata of the hole showed 14 ft. and 6 in. of mixed and soft shale, lying in thin layers, above the roof line. The roof of the hole consisted of hardpan, which held its position. Between the hardpan and the shale, there was a water course about 6 in. in depth and extending the width of the tunnel. Water, in a small volume was flowing from both sides parallel to the tunnel axis into the hole from this water course.

On Oct. 12, another roof collapse occurred at Sta. 29+09, bringing down a mixture of gravel, sand, clay, boulders and broken shale. With the fall came a 3-in. stream of water which continued for 2 hr. The same kind of preliminary warnings as given prior to the roof collapse on Sept. 27, were given for this collapse. This hole measured 6 ft. long and 12 ft. wide at the bottom, 3 ft. long and 10 ft. wide at the top and 18 ft. high above the normal timber line. The lower 14 ft. of the hole consisted of mixed and soft shale. Above this shale, there was 4 ft. of hardpan, the hardpan having collapsed after it had become water-soaked and softened. As soon as the collapse occurred, the tunnel was placed under air pressure, which was gradually increased to 26 lb. per sq. in. A pressure of 10 lb. per sq.in. was secured within 2 hr. and 10 min., two compressors operating, the air locks being located at Sta. 0+85. Thirty hours after the pressure was applied the compressors were stopped, the pressure then being 26 lb. per sq.in. Eleven hours after the compressors were stopped, the pressure gage showed 17½ lb. per sq.in., indicating that the tunnel was reasonably air-tight. No one was injured by this fall.

The hole caused by this roof collapse was firmly cribbed after a 30-hr. struggle. The tunnel was entirely released from air pressure 42 hr. after the collapse. Mining and concreting operations were then resumed, light charges being used in blasting.

Orders were issued to the contractor to install a safety bulkhead within 200 ft. of the heading. Plans and preparations have been completed for installing a safety bulkhead composed of 10x10-in. tongue-and-grooved timbers, reinforced with one 20-lb. 6-in. I-beam and two 35-lb. 10-in. I-beams. It will have a 4x6-ft. material door composed of ¾-in. steel and will also have a 3x3-ft. man door composed of ¾-in. steel. The former door will hang on rollers and close by sliding. The latter door will be hinged. The bulkhead will have its outside perimeter resting in a 6-in. groove in the concrete lining. The present air lock will be used in conjunction with the bulkhead.

Joseph Hanreddy & Co., of Chicago, Ill., is constructing the tunnel. Geo. F. Staal is City Engineer, under whose charge the work is being done. The writer is Resident Engineer for the city, supervising construction.

*Resident Engineer, Linwood Ave. Tunnel, Milwaukee, Wis.

Automobile Exports in the year ending June 30, 1914, are reported by the U. S. Department of Commerce to have been distributed as follows:

	Commercial		Passenger		Ports
England	203	189,099	6,992	5,615,487	1,282,388
Germany	24	18,462	1,411	1,040,787	213,351
France	2	5,070	1,427	919,060	179,351
Russia	2	5,322	926	898,458	14,079
Sweden	1	900	324	253,588	6,140
Italy	1	1,229	342	241,466	50,580
Austria-Hungary	3	7,455	314	190,199	5,198
Rest of Europe	13	21,179	1,372	1,009,173	79,473
Canada	247	474,724	4,377	5,445,052	3,663,879
Cuba	19	33,500	297	254,428	48,217
Mexico	12	17,509	155	239,166	41,508
Central Am. Reps.	13	17,814	118	123,155	28,390
Rest of North America	7	14,866	243	218,241	65,622
Argentina	48	65,225	940	963,586	92,633
Brazil	13	20,449	299	264,992	84,602
Chile	2	10,743	195	160,194	22,405
Uruguay	1	865	183	167,269	21,401
Venezuela	12	28,228	126	102,073	36,286
Colombia			79	69,620	19,970
Peru	3	5,301	36	31,362	5,982
Rest of South America			48	49,305	13,027
China	7	12,700	144	143,619	5,825
Japan	1	900	96	101,195	35,637
Rest of Asia	22	42,058	1,168	961,217	102,555
South Africa	12	11,539	1,618	1,437,883	157,246
Rest of Africa	3	5,067	243	153,411	13,531
Australia and Tasmania	32	37,378	3,099	2,615,896	202,363
New Zealand	39	61,599	1,065	974,708	53,644
Phillippine Islands	38	64,805	614	697,175	69,933
Rest of Oceania	4	7,625	55	51,198	9,016
Grand total	784	1,181,611	28,306	25,392,963	6,624,232

A New Process of Metal Coating

A remarkable new process of coating metal, which was brought out by a Swiss inventor, Schoop, some two years ago, has now been reduced to commercial form, and promises to have industrial applications of great importance. The novel character of this new process may be realized, when it is stated that it is possible by it to apply a metal coating not merely to another metal surface, but to articles of wood, plaster, cement, paper, leather, glass, porcelain and even cloth. What is still more important is that a great variety of metals and alloys can be thus applied. The coating may be extremely thin or as thick as desired; the process is applicable either for delicate decorative work or for the rough work of coating iron and steel articles or sheets with some non-corrosive covering, such as lead, zinc, tin or copper.

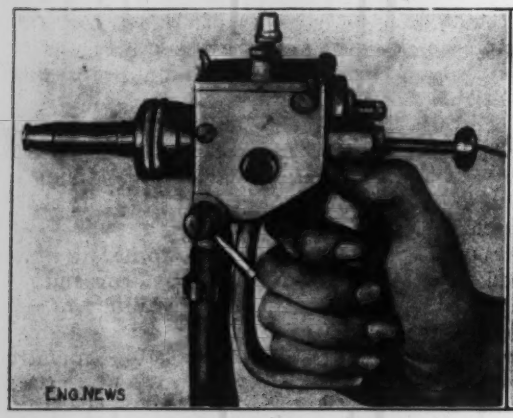


FIG. 1. THE SCHOOP METAL-SPRAYING PISTOL

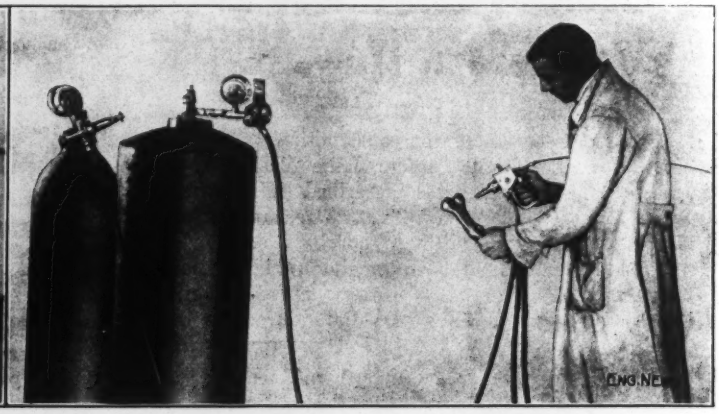


FIG. 2. COATING AN IRON CASTING WITH COPPER WITH THE SCHOOP PISTOL

According to the present outlook, it should be possible to treat many articles of steel and iron now protected by paint, which requires frequent renewal, with a coating of lead or zinc or brass applied by the Schoop process at a cost which will be less than the ultimate cost of repeated applications of paint.

There are only two metal-coating processes now in extensive commercial use—electroplating and dipping.* The electroplating process is chiefly used for coating metal articles with gold, silver or nickel. Iron sheets and pipes are coated with zinc by dipping (the so called galvanizing process), and also with tin. A very serious drawback of the electroplating process is that the film of metal which is deposited is chemically pure, and therefore exceedingly soft, so that it rapidly wears away. Were it possible to apply a coating of gold or silver or nickel alloy instead of the pure metal, the plating would wear several times as long. Further than this, the electroplating process is an expensive one to operate, and is, therefore, confined to articles of considerable value.

The Schoop process of metal coating, now to be described, operates in a manner entirely different from anything ever tried in the arts. Briefly described, a thin wire composed of the metal of which a coating is to be applied, is melted in the flame of an oxy-hydrogen blowpipe, and at the instant of melting is subjected to a powerful blast of compressed air. The article to be coated is held in this air blast a few inches away from the oxyhydrogen flame; the minute particles of metal carried by the blast build up a coating that adheres as firmly as a coat of tin or zinc to a plate of steel dipped in a molten bath. It is, of course, necessary that the surface to be coated shall be perfectly clean. Even the slightest film of grease prevents adherence. In this, of course, this process is similar to other metal-coating processes in which it is common practice to pickle the metal to be coated before it is treated.

The amazing and well nigh incredible thing about the Schoop process is that the particles of metal discharged in the air blast should adhere and form a dense, smooth coating, instead of flying off as dust. While the wire is melted in the oxy-hydrogen jet, the molten metal is instantly congealed by the blast of compressed air, and the particles of metal, as they strike the object to be coated, are at so low a temperature that they can be received on the hand for a moment without injury. In fact, the metal coating can be applied to such inflammable materials as cloth, paper, wood and even celluloid, or the phosphorus-coated end of a match. It is evident, therefore, that the particles of metal on the surface to be coated are in the solid and not in the molten state. They are, however, moving with an enormous velocity, some 3000 ft. per sec.

The invention, as now developed, is radically changed from its original form. At first, the metal to be used for coating was melted and held in a reservoir. A fine jet of this molten metal was atomized by air pressure and directed against the surface to be coated. In that form the apparatus was clumsy, and the process was only adapted to spraying lead and tin. In a later apparatus, fine metallic dust was simultaneously acted upon by heat and air pressure. Some success was attained with this form of apparatus, but the high cost of manufactured metallic dust and its tendency to oxidize rapidly, restricted the use of this form of apparatus chiefly to zinc.

The present form of apparatus is termed a spraying pistol. While it has been used in Europe for some time, it was introduced into this country only six months ago. It is a portable hand tool, weighing only 3½ lb. The pistol is connected by small tubes with reservoirs supply-

*The Sherardizing process, for coating articles with zinc by heating them in a muffle with zinc dust, is in use to a limited extent.

ing oxygen, hydrogen and compressed air. The compressed-air blast nozzle is concentric with the oxy-hydrogen burner. The issuing compressed air drives a tiny turbine which propels friction wheels that feed the wire into the flame.

In a paper on the Schoop process*, by R. K. Morcom, before the Institute of Metals†, the process is thus described:

The essential parts of the machine, or "pistol," as it is called, are a combined melting and spraying jet and a feed mechanism. The metal, in the form of rod or wire, is fed to the melting-flame. The flame can be formed by coal-gas, water-gas, acetylene, hydrogen, etc., burning in air or oxygen according to the metal used. The gases are supplied at such pressures as to prevent blowing out and to insure a highly deoxidizing flame. The spraying-jet can be of carbon dioxide, nitrogen, air, steam, etc.; it is fed at such a pressure as to produce a sufficiently high velocity for successful coating.

To obtain the best adhesion, the surface on to which the metal is sprayed must be thoroughly clean and of an open nature to give a key for the deposit. Sand-blasting with sharp sand has been found best. Shot gives too polished a surface. Such surfaces as fabrics, wood, unglazed earthenware, and asbestos require only freedom from grease, as their surfaces give a natural key.

As at present constructed, the standard pistol uses about 0.55 to 0.6 cu.ft. per minute for every 1 lb. per sq.in. air pressure, so that with an air supply at 80 lb. per sq.in., which is a very suitable figure for ordinary spraying, the air consumption will be from 45 to 50 cu.ft. per minute. The mass of this will be from 830 to 920 grams, and the mass of metal sprayed by this air will be from about 8 grams in the case of iron to about 200 grams in the case of lead.

The action of deposition is probably a complex one. The minute particles of solid metal are driven with such force against the object that, in some cases, they fuse, but, owing to their small relative size, are promptly chilled by the object to which they adhere. If any of the particles are molten or gaseous, they will adhere. In addition, the suddenly chilled particles are possibly, or even probably, in the state of unstable equilibrium found in "Prince Rupert's Drops," and act like so many minute bombs, bursting on impact into almost molecular dimensions, and penetrating the smallest cracks and fissures of the object.

The process requires some care in manipulation, as, by varying the conditions, it is possible to spray porous or non-

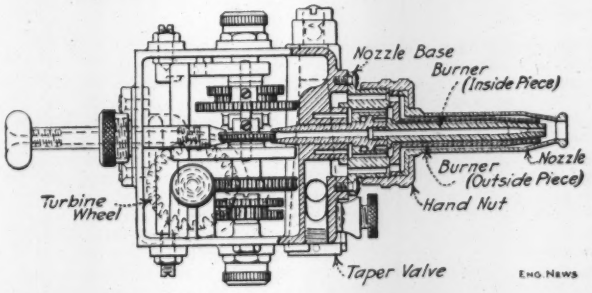


FIG. 3. LONGITUDINAL SECTION THROUGH SPRAYING PISTOL

porous coatings, and, with some metals, anything from a pure metal to a pure oxide. With care, however, nonporous, oxide-free, adherent coatings can be produced of almost any metal on almost any solid.

In addition to metals it is possible to spray fusible nonmetals, or, by stranded wires, alloys of metals or mixture of metals with nonmetals.

The possibilities of the Schoop metal-coating process are so many that time has only permitted a few of them to be commercially investigated. So far, three principal lines have been followed: First, to preserve from corrosion, moisture or chemical action, various objects of wood, paper, stone, cement, iron and steel; second, to use the process for decorative purposes; third, to use the process for copying. As already noted, a thin film of grease on a surface prevents the adherence of the coating. It is possible in this way to make, very quickly and cheaply, perfect replicas of a coin, medal or other object in relief. Of great interest to engineers is the use of the process for covering iron and steel with some non-corrodible metal. We are informed that it is possible to carry out this work at very moderate cost. Those controlling the process say, "The cost of operating the Schoop process in the United States has been carefully ascertained, through experience with the appliance during the last six months. The seven metals most commonly used for protecting or decorating surfaces are lead, zinc, aluminum, brass, German silver, bronze and copper. When the oxygen and hydrogen used are purchased in small quantities in usual containers, the cost of spraying lead, including the cost of wire, compressed air and labor, is between 1 and 2c. per sq.ft., and one pound of lead can be sprayed in less than a minute. The other metal coatings vary with the initial price of raw material and its relative hardness. When the process is used on a large scale and the oxygen and hydrogen are either generated on the premises or purchased at wholesale, a considerable saving from the above figures can be effected."

The use of the Schoop process in the United States is controlled by the Metal Coating Co. of America, with offices in the People's Gas Bldg., Chicago. The president of the company is John Calder, formerly associate manager of the Cadillac Motor Car Co., of Detroit.

*"Engineering," Sept. 25.

†See British patent to Schoop, 1910, No. 5712; 1911, No. 21,066; and to Morf, 1912, No. 2801.

NEWS NOTES

Floods Resulting From a Rainfall of 5 In. In 3 Hr. caused the death by drowning of about 20 persons in San Antonio, Tex., Oct. 23. The property loss is estimated at $150,000.

A 24-In. Water Main Burst in Jackson, Miss., Oct. 13. The main had been installed but about two weeks as a part of the new water-works. The failure is laid to a defect in the pipe.

The Derailment of a Passenger Train on the Missouri, Kansas & Texas Ry., Oct. 19, near Bartlett, Tex., caused the death of the engineman and fireman, and injuries to 15 passengers.

A Fall of Rock and Earth at the quarry of the R. F. Baker Rock Crushing Co., at Bluefield, W. Va., Oct. 19, killed six workmen. The fall came without warning and the men were so deeply buried that blasting had to be resorted to in recovering the bodies.

The Serious Accident at Tiptonford, Mo., Aug. 5, 1914, in which a gasoline motor car on the Missouri & North Arkansas Ry. ran head on into a passenger train on the Kansas City Southern R.R., resulting in the death of 43 persons, was caused by a poor signal system and an apparent misunderstanding of orders, according to the recently issued report of the Interstate Commerce Commission.

A Fast Express Train Was Derailed on the Pennsylvania R.R., 38 miles west of Glen Union, Penn., Oct. 18. The train is known as No. 52, or the Buffalo-Philadelphia express. The derailment was caused by the breaking of an axle on the tender, while the train was running at a speed of 45 mi. per hr. The entire train of three coaches, three Pullman cars, a dining car and a baggage car left the rails, and the engine, tender and baggage car rolled down a 6-ft. embankment. The train was composed of all steel cars and no one of the 100 or more passengers was seriously injured.

Extensive Highway Construction in California—The California State Highway Commission announces that 202 miles of road have been completed and accepted, and that 615.7 miles have been partially completed since bonds in the amount

of $18,000,000 were voted for this project in 1909. Plans for 967.6 miles have been drawn and 818.7 miles have been placed under contract.

Four Commercial Attachés have been appointed by the United States Department of Commerce to travel through South American countries and report upon commercial opportunities for American business firms in those countries. The appointments are as follows: Messrs. A. I. Harrington, for Lima, Peru; Albert Hale, for Buenos Aires, Argentina; Verne L. Havens, for Santiago, Chile; Lincoln Hutchinson, for Rio de Janeiro, Brazil. Mr. Haven's appointment is noted in our personal columns on another page of this issue.

The Watervliet Water Supply Project has been approved by the New York Conservation Commission, provided the supply is filtered in accordance with an advocated statute requiring state-wide filtration. This project was noted in "Engineering News," Feb. 26, 1914, p. 459, and Mar. 19, 1914, p. 641, and interest attaches to its approval on account of its interference with the Charlton project, fostered by the commission, for the supply of Watervliet and neighboring communities (see "Engineering News," July 16, 1914, p. 158.)

Increase in Fares on the San Francisco-Alameda County suburban lines of the Southern Pacific Co., have recently been denied by the California Railroad Commission, on the grounds that such increases would result in the confiscation of large property values created by the earlier rates voluntarily fixed by the company. The commission is of the opinion that a return on cost of electrification and other improvements should be eventually secured though not necessarily at present since the improvements were voluntarily undertaken.

A Receiver Has Been Appointed for the Brazil Railway Co., and its subsidiary, the Madeira-Mamoré Railway Co., which are both incorporated under the laws of the State of Maine. The Receiver is W. Cameron Forbes, former Governor-General of the Philippine Islands. It is reported that most of the stock and bonds are owned aboad. This adds another chapter to the interesting history of the Madeira-Mamoré Ry., for details of which the reader is referred to "Engineering News," Oct. 17, 1907; Oct. 24, 1907; Oct. 31, 1907; Mar. 26, 1908; Nov. 12, 1908; Sept. 26, 1912.

The Diversion of Schoharie Creek into Esopus Creek to give sufficient water to fill the Catskill Aqueduct, New York City, has been authorized by the New York State Conservation Commission. We are indebted to Alfred D. Flinn, Deputy Chief Engineer of the Board of Water Supply of the City of New York, for the following concise description of the project:

The city proposes to divert from the upper part of Schoharie Creek, above a dam at or near Prattsville, Greene County, N. Y., sufficient water to fill the Catskill Aqueduct. Only about half the capacity of the Catskill Aqueduct can be obtained from the Esopus Creek, the development of which is now nearly completed. A large reservoir will be created by a dam near Prattsville, from which the water will be diverted into the Esopus watershed and Ashokan reservoir by means of a tunnel about ten miles long through one of the ranges of the Catskill Mts. Approximately 230 sq.mi. of watershed of the Schoharie Creek will be utilized.

A **Systematic Survey of the City of Chicago** has been begun. This work is being done by the Division of Surveys which was organized early last year with T. C. Phillips, Engineer of Surveys, in charge. The initial appropriation for the year 1913 was $22,500. This specifically provided for a survey of all public streets and alleys entering into or crossing the right-of-way of the Chicago & Western Indiana R.R., with the object of disclosing to what extent the railway had encroached on public ground. The survey of this railway company's right-of-way between Polk and 62d St. showed encroachments to the extent of 476,000 sq.ft. of public property, approximating in value $250,000. This, however, is only a small part of the encroachments disclosed by surveys of the new division in the course of the year. The value of other public land occupied and in use by railway and manufacturing corporations totaled nearly $2,000,000 more. The ultimate object of the new Division of Surveys should be the making of a comprehensive survey of the entire city, including a topographical survey, similar to those of New York, Philadelphia, Baltimore and Cincinnati.—From the 1913 Annual Report of the Department of Public Works of Chicago, Ill.

Fatalities in the Metal Mining Industry for recent years are reported by A. H. Fay, Mining Engineer, U. S. Bureau of Mines, as follows:

	Men employed	Men killed	Fatalities per 1000
1911	165,979	695	4.19
1912	169,199	661	3.91
1913	193,088	683	3.54

The important mining states showing a continuous reduction of fatality rates during 1911, 1912 and 1913 are Idaho, Michigan, Montana, Nevada, New Jersey, South Dakota and Utah—representing, in 1913, 38% of the mining industry. Alaska, Alabama, Colorado, New York, Oklahoma, Tennessee, Wisconsin and Wyoming showed a decreased rate only in 1913 over 1912. These reductions are attributed to the introduction of safety appliances, better supervision and a more strict enforcement of rules and regulations of the mining companies, and a closer observance of state laws. Practically all of the larger companies, and many of the smaller ones, have inaugurated the "safety-first" movement with good results. By first-aid treatment, many injuries have been made of short duration and have been kept out of the "serious" or "fatal" classes.

The "Third" Lock at St. Mary's Falls Canal, Sault Ste. Marie, Mich., was opened for traffic without any special formalities on Oct. 21. This lock, which is 360 ft. longer than the Panama locks, forms an important addition to the present lockage facilities between Lakes Superior and Huron.

The first appropriation for the work was made in 1907, and a coffer-dam surrounding the site was completed in 1909, when a contract was let for the excavation which required two years to complete. The masonry was built in 1912 and 1913, and the machinery and gates were completed this year. The lock chamber is 80 ft. wide by 1350 ft. in length between the inner gates. There are two pairs of operating gates at each end of the lock to guard against accidents, making the total length of the masonry 1715 ft. The sidewalls are 50 ft. high above the floor; those at the ends, forming the gate abutments, are 36 ft. thick, and the sidewalls in the chamber are 26 ft. thick at the base and 12 ft. at the top. The four pairs of operating gates are of steel and the two pairs of guard gates (for unwatering the lock when necessary) are of Western fir. The machinery is operated electrically.

On the first lockage, upbound, the U. S. steamer "Gladwin," the inspection steamer of Col. Mason M. Patrick, the Engineer Officer of the Detroit District, entered the lock first, and was followed by the U. S. steamer "Alfred Noble," the U. S. revenue cutter "Mackinac," the tugs "L. C. Sabin," "S. C. Schenck," "Illinois," and "James Edward." These were followed by the freight steamer "Alva C. Dinkey," which has a length of 600 ft. and beam of 58 ft. In the first down lockage were two loaded steamers, the "James A. Farrell" and the "Richard Trimble" both 600 ft. long by 58 ft. beam, and loaded with iron ore. The combined cargoes was 26,320 tons, probably the largest lockage ever made in point of tonnage.

The traffic through all the locks at Sault Ste. Marie last year was 79,718,344 net tons of freight, with an average value of $11 per ton, or total valuation of about $866,000,000. The lock work was described in "Engineering News," March 5, and April 23, 1914.

The New Union Station at Kansas City, Mo., is to be opened to traffic on Oct. 31. It is located in a different part of the city from the old station and is on a terminal or belt line affording connections with all the railways entering the city. There are 16 station tracks (with room for 24) and two thoroughfare tracks; the station tracks are in pairs, 12½ and 42 ft. c. to c., of sufficient length for two trains of 6 to 14 cars each. While all are through tracks, the station is to be operated on the double-end system, certain roads entering and leaving at one and the others at the opposite end. Mail and express will be handled at both ends, but mainly at the west end. Baggage will be handled by elevators serving the platforms and a transverse subway. There are 14 railways in all, with about 250 trains per 24 hr.

The station building has its main floor at the street level, with track floor beneath and two floors above for offices. It is a low structure, no attempt having been made to utilize the site for a general office building. Its special feature is that the waiting room (165x422 ft.) extends as a one-story structure across the tracks; on each side of this room is a corridor, with stairways to the platforms. Outgoing passengers reach the stairways by doorways (with ticket inspectors) at the sides of the waiting room. Incoming passengers pass out along the corridors, without entering the waiting room.

The tracks are covered by a steel-frame trainshed about 1400x340 ft.; the roof being carried by trusses of 44-ft. span on columns spaced 34 ft. apart along the platforms. Over each pair of tracks is an opening 15½ ft. wide for light and ventilation. The clear height from rail to bottom of truss is about 16 ft.

About ¾-mile west of the station is the engine terminal, with round-house, coaling station, ashpit, etc. Here also is the coach yard, having stub tracks in groups of five, with capacity for 460 cars on the cleaning tracks and 16 on the repair tracks. This yard is piped and equipped to supply

water, compressed air, steam, gas and electric current for charging batteries.

The station with its tracks and accessories is said to represent an expenditure of about $25,000,000; the total cost, including the new approaches, etc., is put at nearly $40,000,000. The entire terminal is owned and operated by the Kansas City Terminal Co., representing the several roads. John V. Hanna is Chief Engineer, and A. C. Everham, Assistant Chief Engineer; Jarvis Hunt, Architect. The entire terminal system was described and illustrated very fully in our issue of Aug. 7, 1913; the tunnel carrying O. K. Creek across the station site, July 31, 1913; and the trainshed, Oct. 8, 1914.

PERSONALS

Mr. L. M. Dooley, former Inspector of Transportation of the Texas & Pacific Ry., has been promoted to be Superintendent of the Rio Grande division, with headquarters at Big Spring, Tex.

Mr. A. S. Lowrie, for many years Chief Engineer of the Montgomery Light & Water Co., Montgomery, Ala., has been appointed Superintendent of the municipal water and electric plant of Dothan, Ala.

Mr. Robert R. Crowell, who was dismissed as head of the Topographical Bureau of the Borough of Queens, New York City, in 1912, has been reinstated by a decision of the Court of Appeals of New York State.

Mr. David T. Day, M. Am. Inst. M. E., Petroleum Expert of the United States Geological Survey, has resigned to engage in private practice. He is succeeded by Mr. John D. Northrop, Geologist, of the U. S. Geological Survey.

Mr. William A. Mitchell has resigned as Director and Treasurer of A. L. Guidone & Co., Inc., General Contractors, to engage in general contracting under his own name, at 2409 Walton Ave., the Bronx, New York City.

Mr. Joseph Billingham, former General Inspector of the American Locomotive Co., Schenectady, N. Y., has been appointed Superintendent of Motive Power of the Grand Trunk Pacific Ry., with headquarters at Transcona, Man.

Mr. Victor T. Noonan, recently Secretary of the general safety committee of the Rochester (N. Y.) Railway & Light Co., has been appointed Director of Industrial and Public Safety of the State of Ohio, a newly created office.

Lieut.-Col. Chester Harding, M. Am. Soc. C. E., Corps of Engineers, U. S. A., recently Engineer Commissioner of the District of Columbia, has been transferred to the Panama Canal, where he becomes Engineer of Maintenance, succeeding Col. H. F. Hodges.

Mr. B. F. Thomas, M. Am. Soc. C. E., U. S. Assistant Engineer, recently in charge of Kentucky River improvements with headquarters at Frankfort, Ky., has been transferred to his old office at Cincinnati, Ohio, as Principal Assistant Engineer of the Cincinnati District, No. 2, Corps of Engineers, U. S. A.

Messrs. E. Darrow, formerly Manager of the Merchants' Heat & Light Co., and R. M. Cass, formerly Electrical Engineer of the Indianapolis Light & Heat Co., have formed the Indianapolis Engineering Co., with offices in Indianapolis, for engineering, appraisal and operating work in connection with public utilities.

Messrs. Frank A. Randall, Assoc. M. Soc. C. E., formerly Chief Engineer of Morey Newgard & Co., Chicago, Ill., and William H. Warner, formerly with D. H. Burnham & Co., have formed a partnership under the firm name of Randall & Warner, Civil and Structural Engineers, with offices at 511 Rector Bldg., Chicago.

Capt. George E. Burd, U. S. N., Engineer Officer, U. S. Navy Yard, New York City, has been appointed Industrial Manager of the Yard under a new system of organization. The Commandant of the Yard will hereafter devote his whole time to military administration, while the work construction and repair will be under Capt. Burd.

Mr. Wm. D. Kerr has resigned as Director of the Bureau of Public Service Economics and has become a member of the firm of Kerr & Kerr, Attorneys, of Chicago. Mr. Kerr has also been appointed to a lectureship in the School of Commerce of Northwestern University dealing with the subject of Transportation Economics and Law.

Messrs. W. H. Ellison and V. B. Stanbery, both of whom were recently employed by the California State Engineering Department and in the structural engineering department of the Panama-Pacific exposition, have formed a partnership under the firm name of Ellison & Stanbery, Structural Engineers, with offices at 251 Kearny St., San Francisco, Calif.

Mr. Lucien S. Johnson, M. Am. Soc. C. E., U. S. Assistant Engineer, in charge of the Big Sandy River improvement, with headquarters at Louisa, Ky., has been appointed Assistant Engineer in charge of the Kentucky River improvement, with headquarters at Frankfort, Ky., succeeding Mr. B. F. Thomas, transferred, as noted eleswhere in these columns.

Mr. C. E. Coolidge, recently Mechanical Engineer of the Denver & Rio Grande R.R., of Salt Lake City, Utah, has been appointed Associate Professor of mechanical engineering at the University of Idaho, Moscow, Idaho. Prof. Coolidge temporarily succeeds Prof. G. L. Larson, who has been granted leave of absence for a year, to take up research work at the University of Wisconsin.

Mr. Charles G. Elliott, M. Am. Soc. C. E., for many years Chief of the Drainage Investigations, United States Department of Agriculture, recently Consulting Engineer, Washington, D. C., has been appointed Chief Engineer of the Peace Creek drainage district, Bartow, Fla. Mr. Elliott has been Consulting Engineer of the project since early in the year. This is one of the largest drainage projects in Florida, comprising about 46,000 acres.

Mr. Henry H. Westinghouse, M. Am. Soc. M. E., formerly Vice-President, has been elected President of the Westinghouse Air Brake Co., of Pittsburgh, Penn., to succeed his brother, the late George Westinghouse. Mr. Henry Westinghouse has been associated with the company for over 40 years, having been General Agent, General Manager and Vice-President. He was one of the founders of Westinghouse, Church, Kerr & Co., and for several years was identified with its management.

Mr. Arthur F. Barnes, M. Am. Soc. M. E., formerly at the head of the Engineering School of Middlebury College, Vermont, has been appointed Dean of Engineering at the New Mexico College of Agriculture and Mechanical Arts, which has recently been reorganized. The school embraces the departments of mechanical, electrical, civil and irrigation engineering. A new engineering building was completed in 1913 and the shops almost entirely reëquipped with modern machinery and tools. Courses of study are being revised and a new and complete course in irrigation engineering will be made a specialty of the school.

Maj. Charles W. Kutz, M. Am. Soc. C. E., Corps of Engineers, U. S. A., recently in charge of works for the defense of Washington, D. C., and of river and harbor improvement work in the Washington district, has been appointed Engineer Commissioner of the District of Columbia, to succeed Lieut.-Col. Chester Harding, transferred, as noted elsewhere in these columns. Maj. Kutz graduated from the United States Military Academy at West Point in 1893. He has been a member of the board of consulting engineers of the United States Reclamation Service, and from 1911 to 1913 he was Chief Engineer of Philippine division of the Corps of Engineers.

Mr. Thomas J. Kennedy, former President of the Superior Construction Co., Ltd., at Sudbury, Ont., has been elected President of the Algoma Central & Hudson Bay Ry. and the Algoma Eastern Ry., with headquarters at Sault Ste. Marie, Ont. Mr. Kennedy began his railway experience with the engineer corps of the Canadian Pacific Ry. in 1874. Later he was Engineer for a contracting firm for the construction of the same railway. In 1885 he entered the operating department of the Canadian Pacific Ry. as Roadmaster and was soon promoted to be Division Superintendent. Later he was General Superintendent and Traffic Manager of the Algoma Central & Hudson Bay Ry., of which he is now elected President.

Mr. George S. Rice, M. Am. Soc. C. E., Consulting Engineer, of New York City, and former Chief Engineer of the old Rapid Transit Commission, which built the first New York City subways, has been appointed Division Engineer of the Public Service Commission to succeed Mr. Frederick C. Noble, M. Am. Soc. C. E., whose resignation was noted in our personal columns of Sept. 17. Mr. Rice was born in Boston, Mass., Feb. 28, 1849, and graduated from Harvard University in 1870. For two years he was Assistant Engineer of the Lowell (Mass.), water-works and of the Boston water-works. For the five years, 1872-'77, he was Division Engineer for the additional water-supply of Boston, and for a year was Assistant Engineer in direct charge of the main drainage works of the city. He then succumbed to the mining fever which followed the great silver discoveries in Colorado, and along with many other young engineers went West, where for several years he was a Mining Engineer in Arizona and Colorado. He returned East in 1887 to become Principal Assistant Engineer of the main drainage works of Boston. The same year he was appointed Deputy Chief Engineer of the New Croton Aqueduct, New York City. In 1891 he returned to Boston as Chief Engineer of the Boston Rapid Transit Com-

mission. Since 1892 Mr. Rice has been located in New York City, for eight years as Deputy Chief Engineer of the Rapid Transit Commission, for four years its Chief Engineer, and for a short time Chief Engineer of the Rapid Transit Commission's successor, the Public Service Commission, First District. Since 1907 he has been in private practice as a consulting engineer.

OBITUARY

Andrew A. Bruch, Manager of Sales of the S. Flory Manufacturing Co. since its foundation, died Oct. 20, at his home in Bangor, Penn.

Nathan W. Condict, of the firm of Steel & Condict, Engineers, Jersey City, N. J., died at the Roosevelt Hospital, New York City, Oct. 20. He was born at Morristown, N. J., in 1834.

Lorenzo Trafton, for many years a Superintendent of Construction for O. W. Norcross and the George A. Fuller Co., Building Contractors, died at his home in Boston, Mass., Oct. 18. He was born in Maine in 1864.

George A. Goodell, General Manager of the Northern Pacific Ry. lines east of Paradise, Mont., died Oct. 3, at his home in St. Paul, Minn., aged 59 years. His railway experience was begun in 1868 as a messenger boy with the Chicago, Burlington & Quincy R.R. He was at one time General Superintendent of the Chicago Great Western R.R. at St. Paul, Minn. He joined the operating staff of the Northern Pacific Ry. in 1907 as General Superintendent of the Central district.

Daniel A. Tompkins, President of the D. A. Tompkins Co., Charlotte, N. C., Engineers and Contractors, died Oct. 18. He was born in South Carolina in 1852. He was educated at South Carolina College and the Rensselaer Polytechnic Institute, where he graduated in 1873. Leaving college he entered the bessemer steel works of John A. Griswold & Co., Troy, N. Y., and for 10 years following was with the Bethlehem Iron Works, Bethlehem, Penn., under the late John Fritz. Later he went into the glass manufacturing business at Crystal City, Mo. In 1882 he established a business in Charlotte, N. C., as a Contracting Engineer, and as such he constructed numerous Southern manufacturing plants. He was the author of several books on the cotton industry.

Arnold Frederick Gerstell, President of the Alpha Portland Cement Co., died at his home in Easton, Penn., Oct. 16, after an illness of only a few hours. He was born at Westernport, Md., 53 years ago. He was educated at Highland Falls Academy, New York, and Hillside College, Michigan. For 12 years he was with the civil engineering staff of the West Virginia Central R.R. and other railways in Maryland and West Virginia. Following 1890, he was for 10 years with the Standard Oil Co., occupying positions as Manager at Cumberland, Md., Wheeling, W. Va., and Pittsburgh, Penn. In 1899 Mr. Gerstell was elected Vice-President and General Manager of the Alpha Portland Cement Co., which at that time owned one small mill with an annual output of 300,000 bbl. He was elected President in 1909. Under his active management the output of the company increased to 7,000,000 bbl. a year. From one small mill the plant grew to six large mills, two at Alpha, two at Martins Creek and one at Manheim, W. Va., and one at Cementon, N. Y. He was active in many other local industries and was a member of many social, educational and philanthropic institutions.

Bernard Richardson Green, M. Am. Soc. C. E., Superintendent of Buildings and Grounds, Library of Congress, Washington, D. C., died at his home in Washington, Oct. 17. He was nearly 71 years old and had been a resident of Washington for 52 years. He was born in Malden, Mass., in 1843. His early education was obtained in the public schools. He graduated from Lawrence Scientific School, Harvard University, in civil engineering in 1863. He entered the Engineer Department of the United States Government the same year and during and after the Civil War was engaged in fortification and river and harbor work on the coasts of Maine, New Hampshire and Massachusetts. He first went to Washington in 1877 to take charge of the construction of the new building for the State, War and Navy Departments under Lieut.-Col. (later Brig.-Gen.) Thomas L. Casey. While engaged chiefly on this work Mr. Green acted as professional adviser and assistant to Col. Casey on many local engineering structures including the Washington Aqueduct and its projected extension and the strengthening of the foundations of Washington Monument. He is said to have devised the general scheme of underpinning and strengthening the monument, and to have laid out and supervised the construction of the earth mound around the base of the shaft. He supervised the construction of many other famous buildings, the most notable of which is the beautiful Library of Congress. Under the direction of Gen. Casey, Mr. Green organized the office and construction work so efficiently that the building was expeditiously completed well within the appropriation. Mr. Green also had charge of construction of the Washington Public Library building and was consulted on the construction of public buildings in many cities. He not only was Superintendent of Construction but suggested and made many changes in designs and plans which were of great importance. Moreover he was an inventor of library fittings and devices, including the book stacks and carrying system of the Library of Congress as well as special racks for maps and newspapers. He was a member of many scientific and learned societies and was a prominent and useful member of the American Unitarian Association. He is survived by four children, one of whom is Bernard Lincoln Green, M. Am. Soc. C. E., Vice-President of the Osborn Engineering Co., Cleveland, Ohio. The following tribute was paid to the long, honest and honorable service of Mr. Green on Mar. 7, 1913, on the completion of his 50 years of service for the government:

On this day you will have completed fifty years' of service to the United States. To few, indeed, has such a term been vouchsafed, and, while the individual qualities which have characterized your own relation with the government are happily not unique in its history, few men, indeed, can show a record which combines qualities so useful in a union so complete of inventive skill, technical knowledge, executive energy, simplicity in method, firmness without bluster, persistent and unselfish devotion, inflexible integrity and a modesty more than content to be anonymous.

The permanent memorials of these qualities are in stone and marble. They are in structures of beauty, of dignity and of efficiency, with which your name will forever be associated. But the friends—of yourself and of the public service—whose names are signed below, usurping a privilege in which scores of others would have been glad to join, desire to offer you their acknowledgments, their congratulations and their warmest wishes, and to couple with these a memento of the day which will, they hope, help to divert such leisure hours as you may allow yourself hereafter.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS.
Oct. 28-31. Congress at Milwaukee, Wis. Headquarters, 71, Sentinel Bldg., Milwaukee, Wis.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

INDUSTRIAL WELFARE AND EFFICIENCY CONFERENCE
Nov. 16-20. Conference at Harrisburg, Penn. Secy., R. M. Pennock, Harrisburg, Penn.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 19-20. Annual meeting at Columbus, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Nov. 30-Dec. 1. Annual meeting at New York. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 1-4. Annual meeting at New York City. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 2-4. Convention at Washington, D. C. Secy., D. Knickbacker Boyd, The Octagon, Washington, D. C.

AMERICAN MINING CONGRESS.
Dec. 7-11. Annual meeting at Phœnix, Ariz. Secy., J. F. Callbreath, Denver, Colo.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 9-12. Convention at Richmond, Va. Secy., C. A Prosser, 140 W. 42d St., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 10-11. Annual meeting at New York City. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 14-18. Convention at Chicago, Ill. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Madison, Wis. Secy., F. M. White, Madison, Wis.